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SOME PATHOLOGICAL STUDIES ON *ALTERNARIA TENUIS* AUCT SENSU NEERGAARD CAUSING ROT OF PEAR (*PYRUS COMMUNIS* L.)

By

R. N. TANDON *and* A. K. GHOSH

Department of Botany, Allahabad University

[Received on 25th September, 1961]

The value of fruits as food is now universally recognised. Many fruits like pear, apple, orange, grape, peach, etc., often require a long transportation from the centres of production before they are sold. It is, therefore, desirable to protect them from invasion and spread of diseases during transit, storage and in the market.

The problem of controlling storage-fruit diseases has drawn the attention of workers in various parts of the world. The works of Brooks and Fisher (1914), Horne and Horne (1920), Kidd and Beaumont (1924), Bartholomew (1926), Newton (1928), Huber (1930, 1932), Baker (1938), Simmonds and Mitchell (1940), Rose *et al.* (1951) are some of the important contributions in this field. Cook (1950) has made a survey of the diseases of storage-fruits that occur in the United States of America.

In India, Dastur (1915,1916) carried out investigations on ripe rot of bananas, Dey and Nigam (1933) on soft rot of apples, Kheswalla (1936) on fruit diseases in Baluchistan, Ghatak (1938) on orange rot, Prasad (1938) on rot of pears, Mehta (1939) on *Rhizopus* rot of apples, Singh (1941) on soft rot of apples, Sinha (1947) on storage rot of fruits, Tandon and Tandon (1948) on *Pestalotia* rot of apples, Singh and Grewal (1953) on soft rot of pears, Grewal (1954) on *Alternaria* rot of apples and Tandon and Bhatnagar (1958) on *Aspergillus* rot of apples.

Alternaria rot of apples has been reported from various parts of the world. Rose *et al.* (1951) have reported it from U. S. A. Harrison (1935) and Carpenter (1942) also isolated *Alternaria* sp. from core rot of apples. Kheswalla (1936) observed it in Baluchistan and Singh (1943) in Uttar Pradesh. Grewal (1954) has also isolated it from apples obtained from Allahabad.

The present paper deals with the pathological studies of *Alternaria tenuis* causing rot of pear (*Pyrus communis*—variety 'Nakh'). Grewal (1954) observed that *A. tenuis* isolated from apple could cause the rot of pear when artificially inoculated but he failed to find diseased fruits in nature.

MATERIAL AND METHOD

Alternaria tenuis was isolated from diseased portion of pear ('Nakh') obtained from the local market. The isolate was purified and single-spore culture was

prepared by dilution method. All subsequent experiments were carried out with purified single-spore culture.

At first the following five different methods of inoculation were tried to find out the most successful one.

1. Granger and Horne's (1924) method :

In this method a cork-borer of 1/2 cm. diameter was sterilized and inserted into the fruit upto about 1 cm. and was then taken out with a bit of flesh of the fruit. The inoculum was placed in the pit and the piece of flesh was inserted back to its original position. The wound was then sealed with wax.

2. Injury method :

The fruits were injured by inflicting shallow wounds with curved scalpel. The inoculum was placed at the injured region.

3. Spore-suspension method :

A spore-suspension was sprayed on the surface of uninjured fruits.

4. Inoculation at the stalk end without injury :

Inoculum was placed at the stalk end without injury.

5. Inoculation at the calyx end without injury :

Inoculum was placed at the calyx end without injury.

The inoculated regions, in methods 2 to 5, were kept moist for 48 hours with wet sterilized cotton pads.

In all other experiments the method described by Granger and Horne (1924) was used for artificial inoculations.

For all the experiments healthy fruits of similar size and approximately of same maturity were employed. After inoculation all the fruits were kept inside sterile polythene bags.

The effect of different environmental conditions on the advancement of the rot was studied. For comparing the results of various treatments the decayed spot at the surface of the fruit was measured along two diameters at right angles. Each fruit was then bisected and the depth of the lesion was measured. From this the approximate volume of the rot was calculated by applying the formula for a cone (*i.e.* volume of a cone $= 1/3 \times \pi r^2 \times h$, where r is half the average diameter of the lesion at the surface and h is the depth of the lesion).

In each treatment the result obtained was determined on the basis of an average of at least four replicates. Controls were maintained in all cases.

Throughout this investigation reisolations were made after the incubation period.

Ridgway's (1912) 'Color Standards and Color Nomenclature' was used for the determination of different colours.

OBSERVATIONS

Symptoms :

The first sign of the disease appeared as a circular 'Apricot Buff' spot. Soon it increased in diameter and changed the colour to 'Chaetura Drab'. As the patch increased further the colour of the central portion of the patch changed into 'Chaetura Black'. Alternating light and dark coloured rings were often produced near the central part of the infected region. The rot extending inside

PLATE I

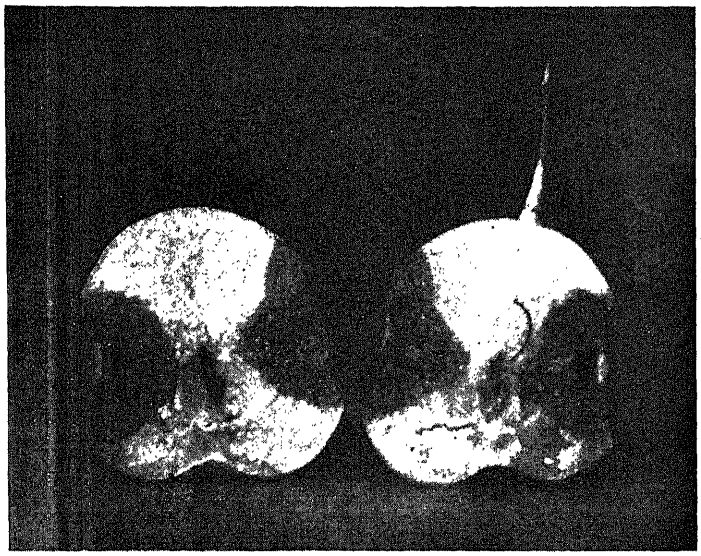

Fig. 1. Showing an infected pear in cross-section.

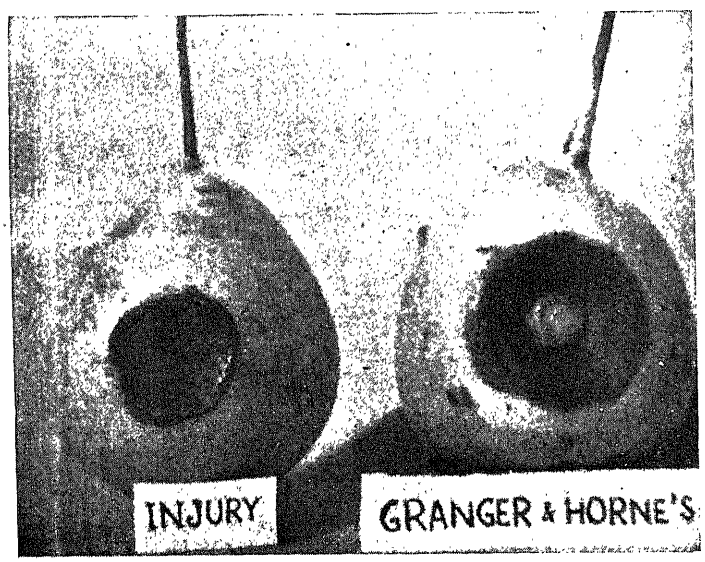

Fig. 2. Showing rot, caused by *Alternaria tenuis*, after 20 days of inoculation by injury and Granger & Horne's methods.

the fruits was mostly conical though rarely it showed hemispherical outline (Plate 1. fig. 1). The rotten flesh of the fruit was brownish in colour, softer than the healthy portion, but it was not watery.

Under favourable conditions of storage the first symptom appeared within 10 days of inoculation. The lesion reached a diameter of about 3 cm. in 20 days and the whole fruit decayed after 35–40 days.

Pathogenicity test :

Pathogenicity of the fungus on pear was tested by inoculating the fruits with *A. tenuis.*

Different methods of inoculation were tried and both injured and uninjured fruits were inoculated. It was found that the injured fruits developed the disease. The progress of the rot was faster when the inoculum was placed inside by Granger and Horne's method than by Injury method (Plate 1. fig. 2). No infection was observed on uninjured fruits when spore-suspension was sprayed on the surface, when the inoculum was placed near the calyx end or when the inoculum was placed near the stalk end. In every case the control fruits remained healthy.

Cross inoculations :

Cross inoculations were tried on two varieties of apples, (*a*) "Golden delicious" and (*b*) "Ambri Kashmiri". It was observed that both the varieties were susceptible but the rate of advancement of the decay was faster in "Ambri Kashmiri" than in "Golden delicious" variety.

In all the following experiments the effect of different environmental factors on the advancement of the disease was studied with both pear and the "Ambri Kashmiri" variety of apple.

Effect of temperature :

Both pears and apples were inoculated with the fungus and they along with some control fruits were kept at 7°C, 14°C, 20 ± 2°C and 30°C. The observations were made on the 21st day after inoculation.

It was found that in both the fruits there was no decay at 7°C. They showed the disease at other temperatures and in each case the intensity of loss was greater at a higher temperature. In pears the total loss per fruit at 14°C was 0·41 c.c. and it increased to 1·78 c.c. at 20°C and 5·37 c.c. at 30°C. The loss was slightly greater in apples as the corresponding values were 0·88, 5·36, and 13·27 c.c. respectively.

The effect of some humidities was also studied. For this inoculated fruits were kept at 0% relative humidity (maintained inside desiccators containing fused $CaCl_2$), 13 to 19% relative humidity (atmospheric humidity at the time of experimentation) and 100% relative humidity (maintained inside bell-jars containing water).

It was observed that the rot advanced more rapidly at higher humidity. On the 21st day after inoculation the total volume of rot of pears at 20°C and 0, 15–19 and 100% relative humidities was 1·02 c.c., 1·57 c.c. and 4·72 c.c. respectively. The corresponding figures for apples were 2·36 c.c., 5·37 c.c. and 13·28 c.c. respectively.

The fruits were stored under different conditions of light (complete darkness, intermittent light and continuous light of about 100 lux). It was found that the spread of the disease was most rapid in complete darkness and least in continuous light. Intermediate condition was observed in intermittent light. The losses for

pears were 1·22 c.c., 1·90 c.c. and 3·78 c.c. in continuous light, intermittent light and total darkness respectively. The corresponding losses for apples were 2·26 c.c., 5·28 c.c. and 10·50 c.c. The effect of light was, thus, more evident on apples where the spread of the disease was correspondingly much slower in continuous light.

DISCUSSION

In the present investigation infection was only possible when fruits were injured. Tandon and Tandon (1948) working on *Pestalotia* rot of apples and Tandon and Bhatnagar (1958) on *Aspergillus* rot of apples have reported that their organisms could infect the fruits even when they were inoculated without any injury at the stalk or calyx ends. This was not possible for *Alternaria tenuis* infecting apples or pears. In this respect the present rot differs from the other two and the losses from it can be saved by preventing injury to the fruits.

The organism was not a specialized parasite because it was found that the pear isolate could infect apples. Similarly Grewal (1954) had observed that the apple isolate could infect pears.

Both "Golden delicious" and "Ambri Kashmiri" varieties of apple were susceptible, but the disease spread more rapidly on the "Ambri Kashmiri" variety. This was probably due to the fact that the "Golden delicious" variety was more acidic. Physiological studies of this fungus by Ghosh (1960) have revealed that the growth of *A. tenuis* was poor on acidic media.

Grewal (1954) working on *Alternaria* rot of apples and Tandon and Bhatnagar (1958) on *Aspergillus* rot of apples have shown that temperature had a marked effect on the spread of the disease. The present investigation showed that higher temperatures (20°C–30°C) were favourable for the rot and the disease failed to appear at 7°C. It is thus evident that cold storage of the fruits will prevent losses from this disease.

It was also observed that inspite of the presence of high amount of water inside the fruit tissues an external supply of high humidity had a marked effect on the advancement of the disease.

Tandon and Tandon (1948) and Tandon and Bhatnagar (1958) have reported that light played an important role in the spread of rot in apples. The present investigation also showed that continuous light had an adverse effect on the advancement of rot in pears and apples but it could not control the disease fully.

SUMMARY

A fruit rot of pears was observed in the market and *Alternaria tenuis* was isolated from the rotten fruits. The pathogenicity of the organism was established and it was also found that it could infect "Golden delicious" and "Ambri Kashmiri" varieties of apples. The disease did not spread at 7°C. The losses were observed at higher temperatures and the maximum rot was developed between 20°–30°C. The spread of the disease was also favoured by high humidity and darkness. Losses could be prevented by avoiding injury and storing the fruits at a low temperature (7°C).

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EFFECT OF *PROTOMYCES MACROSPORUS* ON THE SUGAR MAKE UP IN THE LEAVES AND FRUITS OF *CORIANDRUM SATIVUM*

By

J. S. GUPTA *and* S. C. GUPTA

Botanical Laboratories, Agra College, Agra and D. S. B. Government College, Naini Tal

[Received on 28th August, 1961]

INTRODUCTION

The plant *Coriandrum sativum* L is widely cultivated throughout India for its great demand as spice and for its importance both in Ayurvedic as well as Yunani system of medicine. This plant is commonly parasitised by *Protomyces macrosporus* Unger which causes stem-gall disease. About 15% loss in the yield due to the stem-gall disease has been estimated by Gupta (1954) in the fields of Gwalior. Vaghani and Thakor (1958) have reported the presence of glucose, fructose and sucrose only in the dried and healthy fruits of coriandrum. The present investigation was undertaken to investigate whether any change takes place in the suger make up of diseased tissues of coriandrum. The work was independently carried out by the two authors in the two laboratories.

EXPERIMENTAL

Healthy and diseased leaves and fruits were separately collected, dried at 80°C and powdered. Equal amounts of 80% ethanol and the powder (v/w) were mixed in a glass stoppered tube and left at room temperature for 24 hours. The clear liquid was spotted on Whatman filter paper No. 1 in 0·004 ml quantity along with the known sugars (0·002 ml of 1% solution). The chromatograms were developed separately with butanol-acetic acid-water (4 : 1 : 5, v/v) and butanol-pyridine-water (6 : 4 : 3, v/v) solvent in descending way for 24 hours. After development, the chromatograms were air dried, sprayed with benzidine reagent (0·5 gm benzidine, 10 ml acetic acid, 10 ml 45% trichloroacetic acid and 100 ml 95% ethanol), again air dried and then kept at 90°C for 5 minutes for the detection of sugar spots. The results are given in Table 1.

TABLE 1

Sugars present in the healthly and diseased tissues

Specimen.	Sugars present
Healthy leaves	Glucose, fructose, sucrose and raffinose
Diseased leaves	Glucose
Healthy fruits	Glucose, fructose, sucrose and raffinose
Diseased fruits	Glucose

It was clear from the results that healthy leaves and fruits of *Coriandrum sativum* have four sugars, *viz.* glucose fructose, sucrose and raffinose, and not three as ware reported by Vaghani and Thakor (*loc. cit.*). It was also noted that the leaves and fruits of the infected plants of coriandrum with *Protomyces macrosporus* do not have fructose, sucrose and raffinose in them.

SUMMARY

Only glucose, fructose, sucrose and raffinose were chromatographically detected in the healthy leaves and fruits of *Coriandrum sativum*. After the infection of *Protomyces macrosporus* only glucose was found to be present in the diseased leaves and fruits of the plant.

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ON TWO NEW FAMILIES OF SUPERFAMILY HEMIUROIDEA FAUST, 1929 : OESOPHAGICOLIDAE n. fam. FROM MARINE SNAKES AND ARNOLIDAE n. fam. FROM MARINE FISHES

By

H. R. MEHRA

Allahabad

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Yamaguti (1933) created the genus *Oesophagicola* with *O. laticaudae* as the genotype and only species for distomes obtained from the lower part of the oesophagus and stomach of marine snake *Laticauda laticauda* and included it in his new subfamily Oesophagicolinae under the family Opisthorchiidae Braun, 1901. This subfamily differs much from the latter family. It comes so close to the Hemiuridae that it becomes necessary to elevate it to the rank of a new family. The distomes are robust, moderately large with thick cuticle and strong sub-cuticular musculature. The peripheral parenchyma contains refractive substance. The suckers are large ; acetabulum is pre-equatorial and smaller than oral sucker. The oral sucker is strongly developed and provided with upper preoral lip. The oesophagus is short, wide, lined with a thick cuticle and turns on itself before opening into caeca. The caeca are wide and sinuous, extending to posterior extremity. The testes lie tandem near the hinder end. The cirrus sac is absent. The vesicula seminalis and ductus ejaculatorius are tortuous. The latter opens along with metraterm just in front of acetabulum into a conspicuous large genital atrium. The vitellaria are branched, composed of tubular acini or lobes lying on the dorsal surface between lateral margins and median line extending from behind acetabulum to hinder end. The uterus occupies entire breadth of body ventral to caeca between acetabulum and posterior testis and is strongly convoluted into complicated coils. The eggs are numerous, small and thick shelled showing a ridged opercular line and containing segmented ova. The excretory system is remarkably different from that of the Opisthorchiidae. The excretory bladder is Y-shaped with a long main stem bifurcating behind acetabulum into very long wide cornua with sinuous wall, which pass along the caeca, extend to the sides of pharynx and oral sucker and are united anteriorly by a transverse commissure dorsally to oral sucker. Yamaguti (1933) says : "From the structural point of view it is a typical esophagostomachal trematode, unlike the known members of Opisthorchiidae which live in the biliary system." He, therefore, created for *Oesophagicola* a new subfamily Oesophagicolinae but he included it in the family Opisthorchiidae. We, on the other hand, think that this subfamily stands closer to the family Hemiuridae Luhe, 1901 and may well be elevated to the rank of a new family under the superfamily Hemiuroidea Faust, 1929. It stands somewhat intermediate between the Hemiuridae and Opisthorchiidae. It differs from the former in the oral sucker being larger than acetabulum, reverse to that in the Hemiuridae and immediately pre-acetabular position of the genital pore. In the Hemiuridae the genital pore lies more anteriorly near the intestinal bifurcation, pharynx or oral sucker. The presence of oral lip on the upper side of the oral sucker, the excretory system, the habitat of the trematodes in the oesophagus and stomach of its hosts, however show its close affinity with the latter family. Price (1940) included Oesophagicolinae Yamaguti, 1933 in the family Acanthostomidae Poche, 1926. He says : "Yamaguti places this subfamily in the Opisthorchiidae, but owing to the fact that the branches of the excretory vesicle extend into the anterior part of the body it cannot be

retained in that family." The anterior union of the long cornua of excretory vesicle by a transverse commissure dorsally to oral sucker precludes it equally well from being placed in the family Acanthostomidae Poche, 1926. The position of testes near the end of the body, immediately pre-acetabular position of genital pore and absence of cirrus sac in Oesophagicolinae are the only characters, which show its resemblance to Opisthorchiidae or Acanthostomidae. But the totality of organisation, particularly the excretory system and vitellaria composed of branched tubular acini and the habitat of these trematodes with correspondingly modified bodywall out weigh in favour of its Hemiuridae affinities. We, therefore, exclude the Oesophagicolinae from the Opisthorchiidae or Acanthostomidae and elevate it to the rank of the new family Oesophagicolidae under the superfamily Hemiuroidea Faust, 1929.

Oesophagicolidae n. fam.

Family diagnosis.—Hemiuroidea. Body robust, moderately large, fusiform, with thick cuticle and well developed sub-cuticular musculature. Suckes well developed. Oral sucker larger than acetabulum, strongly developed and provided with upper lip. Prepharynx absent ; pharynx stout ; oesophagus short, lined with thick cuticle and turned on itself before opening into caeca. Caeca wide, sinuous extending to posterior extremity and lined with tall columnar epithelium. Genital pore median, immediately pre-acetabular with wide opening. Genital atrium conspicuous, large. Testes tandem near posterior extremity. Cirrus sac absent. Vesicula seminalis and ductus ejaculatorius tubular and tortuous. Ductus hermaphroditicus absent. Ovary pre-testicular. Receptaculum seminis behind ovary. Vitellaria post acetabular, branched composed of tubular acini in dorolateral fields between lateral margins and median line, extending from just behind acetabulum to hinder end. Uterus strongly coiled filling entire breadth of body between acetabulum and hinder end of anterior testis. Metraterm well differentiated with heavy cuticular lining. Excretory vesicle large, Y-shaped with long median stem bifurcating behind acetabulum into very long and wide cornua extending to oral sucker and united anteriorly by transverse commissure. Eggs numerous small and thick shelled with a ridged opercular line. Parasitic in oesophagus and stomach of marine snakes.

Type genus : *Oesophagicola* Yamaguti, 1933.

We elevate Arnolinae Yamaguti, 1958 to the rank of family Arnolidae n. fam. as it differs much from the family Hemiuridae Luhe, 1901 on account of the presence of a well developed pyriform cirrus sac enclosing tubular, strongly convoluted vesicula seminalis and well developed prostate complex situated behind intestinal bifurcation and absence of ductus hermaphroditicus. Testes lie obliquely and widely separated from one another by uterine coils in hinder half of body. Ovary lies immediately behind posterior testis with vitellaria as two compact lobed masses behind it closely in front of hinder extremity. In the character of its cirrus sac it resembles the family Azygiidae Odhner, 1911 and in its vitellaria it is typically a Hemiurid. The excretory vesicle is long with a strongly S-shaped median stem bifurcating immediately in front of anterior testis and small distance behind acetabulum into two long cornua which extend forward and are united over the oral sucker. The genital pore is bifurcal. The acetabulum is much larger and stronger than oral sucker and lies apart from it. We restrict the family Hemiuridae to distomes which lack a cirrus sac and possess the vesicula seminalis and prostatic complex free in parenchyma. Ductus hermaphroditicus or hermaphroditic pouch is present in Hemiuridae or pars prostatica opens into

genital sinus. So Arnolidae n. fam. which possesses a cirrus sac enclosing convoluted vesicula seminalis and well developed prostatic complex should be recognised as a valid family. It, however, resembles Hemiuridae in the character of its compact, somewhat lobed postovarian vitellaria. Its excretory vesicle with a long S-shaped median stem and long cornua extending to oral sucker and united anteriorly is characteristic of this family. The family stands intermediate between Hemiuridae and Azygiidae. The acetabulum lies much behind anterior extremity quite apart from oral sucker as in the Azygiidae, reverse to the usual condition in the Hemiuridae. The Azygiidae possesses follicular vitellaria, and immediately pre-acetabular genital pore. The cirrus sac is immediately pre-acetabular in Azygiidae but it is bifurcal in Arnolidae n. fam. In the subfamilies Leuceruthrinae Goldberger, 1911 and Proterometriinae Yamaguti, 1958 of the family Azygiidae the oral sucker is much larger and stouter than acetabulum. In the genus *Azygia* Looss, (subfamily Azygiinae Luhe, 1909) the two suckers are subequal or the oral sucker slightly larger, but in *Otodistomum* in which the oral sucker is surmounted by preoral lobe, the acetabulum is larger than oral sucker. It appears to us that the subfamilies of the Azygiidae are difficult to maintain as they are based on the size of the suckers, extension of the vitellaria and pre-testicular or post-testicular ovary. In Leuceruthrinae the ovary is post-testicular, whereas in Proterometriinae and Azygiinae it is pre-testicular. In *Proterometra macrostoma* Horsfall, 1933 the testes and ovary lie so close together near posterior extremity, the latter just in front of the former that the position of the ovary with respect to the testes may be considered as a variable feature in the family. We, therefore, drop the subfamilies Proterometriinae Yamaguti, 1958 and Leuceruthrinae Goldberger, 1911 and maintain only Azygiinae Odhner, 1911.

The family Arnolidae n. fam. belongs no doubt to the superfamily Hemiuroidea Faust on account of the character of its compact post-ovarian vitellaria and bifurcal genital pore. But on account of its well developed pyriform, post-bifurcal cirrus sac containing vesicula seminalis and prostatic complex it comes near Azygiidae Odhner. It is a valid family characterised by its cirrus sac, position of gonads, vitellaria and excretory vesicle with a long strongly S-shaped median stem bifurcating in front of anterior testis into long cornua united anteriorly over the oral sucker.

Arnolidae n. fam.

Family diagnosis.—Hemiuroidea Faust : Body small, cuticle thick, smooth. Suckers well developed and wide apart. Acetabulum much larger and stouter than oral sucker, pre-equatorial. Prepharynx absent, pharynx smaller than oral sucker ; oesophagus practically absent ; caeca winding anteriorly, terminating at hinder end. Genital pore bifurcal. Testes widely separated from one another by uterine coils, post-equatorial, oblique. Cirrus sac well developed, small, pyriform immediately behind intestinal bifurcation. Vesicula seminalis and prostatic complex enclosed in cirrus sac. Ductus hermaphroditicus absent. Ovary immediately behind posterior testis. Receptaculum seminis present. Laurer's canal absent. Vitellaria two compact lobed masses, immediately behind ovary near posterior extremity. Uterus strongly convoluted, intercaecal between acetabulum and vitellaria, not extending to posterior extremity. Excretory vesicle with long, strongly S-shaped median stem bifurcating immediately in front of anterior testis and behind acetabulum into two long cornua united anteriorly over oral sucker. Eggs small, numerous. Parasitic in stomach of marine fishes.

Type genus : *Arnola* Strand, 1942 syn. *Arnolida* Vlasenko, 1931, pre-occupied.

Genotype and single species : *A. microcirrus* (Vlasenko, 1931).

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BIONOMICS AND CONTROL OF RED HAIRY CATERPILLAR, (*AMSACTA MOOREI* BUTL.)

By

A. S. SRIVASTAVA

Entomologist to Government, U. P. and Officer-in-charge, Plant Protection Service, Uttar Pradesh, Kanpur

and

B. K. GOEL

Senior Entomological Research Assistant, Section of Entomologist to Government, U. P., Kanpur

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INTRODUCTION

The red hairy caterpillar, *Amsacta moorei* Butl. (Lepidoptera : Arctiidae) locally known as *kamla* or *bhurdli*, is fairly common in loose and sandy soils in this State. Severe epidemics of the pest have resulted in the wholesale destruction of the cultivated *Kharif* crops and sometimes the caterpillars have been observed to leave nothing in the entire fields. The losses inflicted to the cultivators by this pest have been enormous.

DISTRIBUTION

This pest has been reported to be of common occurrence in Punjab, Delhi, Madhya Pradesh, Madras and Uttar Pradesh. In this state the reports of its severe outbreaks have been received from Bijnor, Meerut, Muzaffarnagar, Agra, Dehradun, Saharanpur, Rampur, Bareilly, Mainpuri, Lakhimpur Kheri, Pratapgarh, Gorakhpur and Deoria districts. The pest thrives well in *bhur* or *bhat* soils.

HOST PLANTS

The caterpillars are practically polyphagous in habit and feeds on almost all kinds of green vegetation that comes in their way like leaves of *sanai*, *urd*, *moong*, *juar*, *lobia*, *dhaincha*, *guar*, *til*, cotton, maize, *bajra*, groundnut and a number of weeds *sitabani*, *duddhi*, *ak*, etc. In certain cases even the fruit trees viz., *aonla*, *guava*, *loquot*, etc., have been observed to become infested but this is rare.

LIFE HISTORY

In the tract where this insect appears as a pest, the moths begin to emerge from hibernating pupae of the previous year after a soaking monsoon rain has fallen during the second fortnight of June or beginning of July. After the first soaking monsoon showers have fallen the pupa which lie embedded deep in the soil transforms into a moth which finally breaks its way up. There appears to be only one active generation of the pest in a year.

The Adult :

The moths (Fig. 5) can be easily recognised having their wings white with a red margin on the costa of the forewing and a submarginal series of four black spots on the hind wing. The antennae are black, head white and the collar

being with a crimson line behind it. The thorax is white and the abdomen is red above with a series of seven black dorsal spots and white below with two series of black lateral spots numbering six and five, respectively. The distinction of sexes is easy. The female is bigger and thicker in size with a clear round fleshly ball at the genital organ, while the male is smaller having a slight projection of the last anal segment.

The moths are rarely seen in the field during day time but during nights become very active. Copulation takes place with the sexes facing opposite to each other. The moths are greatly attracted towards burning lights during night and over 2000 moths were attracted on a single night on two petromax lanterns.

The Egg :

The eggs (Fig. 1) are laid by the females in masses on the lower surface of the leaves of early sown *Kharif* crops or weeds which are arranged systematically in a line and are round in shape. The colour is yellowish white when freshly laid but on reaching maturity changes to dirty white. Hatching starts in 3–4 days.

The Caterpiller :

As the common name hairy caterpillar suggests the larvae of this insect have a thick crop of hairy protrusions on the dorsal and lateral sides of the body. These brownish to dark brown out-growths emerge from the special glands on the joints of each segment on the body of the caterpillar.

The caterpillar on hatching is very tiny and dirty in colour. They feed gregariously in bands on the leaves, mostly on the undersurface, and as they grow disseminate to other plants affecting the entire field. It is a voracious feeder and devours the tender foliage of the plants at a devastating speed. The colour turns to brown and deep brown with a tuft of hair on the dorsal and lateral sides of the body. The advanced stage caterpillar is very active and can move considerably fast ; when they are touched they coil up and feign death. The caterpillars (Fig. 2) become full fed in 3–4 weeks and in this period devour the foliage of the young plants. It measures about $2\frac{1}{2}''$ in length. In U. P. the damage chiefly occurs from the third week of June till the beginning of August. At this stage the caterpillar stops feeding and moves in search of a suitable site for pupation. Their gregarious nature is well exhibited at this stage also when a number of caterpillars may be observed to be resting together underneath thickly grown, crops, weeds and trees. A sudden disappearance of the caterpillars from the fields is observed at this time.

The Pupa :

The fully grown caterpillars have been observed to enter the holes in the field and at raised places in waste lands, *mends*, etc. They bury sufficiently deep in the loose soil and make a cocoon with the help of body hair and surrounding soil and turn into pupae. (Figs. 3 and 4). These pupae have been recovered from the soil at varying depths ranging from 1 ft. to $2\frac{1}{4}$ ft. in district Deoria. It would be interesting to note that due to the pupae being buried so deep in the soil escape destruction by ploughing and field operations. The pupae after passing a life of concealment of over ten months in the soil emerge as adult moths during next June - July after a soaking rain has fallen. The time of pest appearance, however, coincides with the sowing of *Kharif* crops after the break of monsoon.

CONTROL MEASURES

To evolve a satisfatory measure of control of the pest, insecticidal trials were conducted during July 1960 on *sanai* crop at the Government Seed Multiplication Farm, Pirthvipur, district Bijnor. In order to eliminate the migratory effect of

Life-history of

Red hairy caterpillar pest, *Amsacta moorei* Butl., attacking Kharif crops

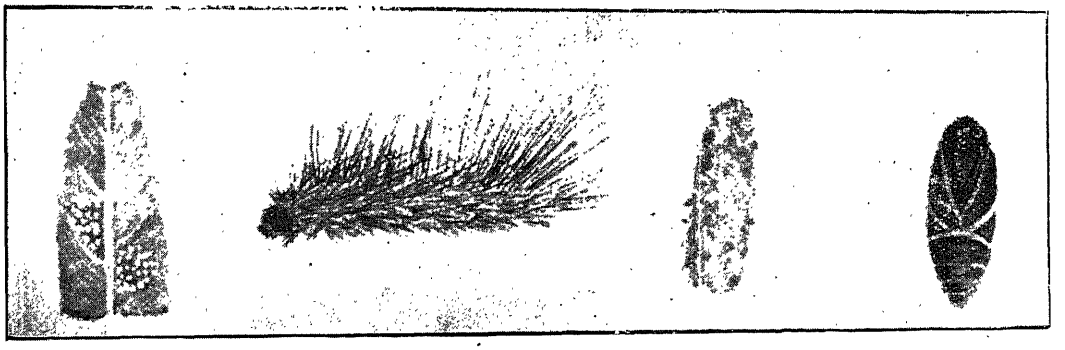


Fig. 1 Fig. 2 Fig. 3 Fig. 4

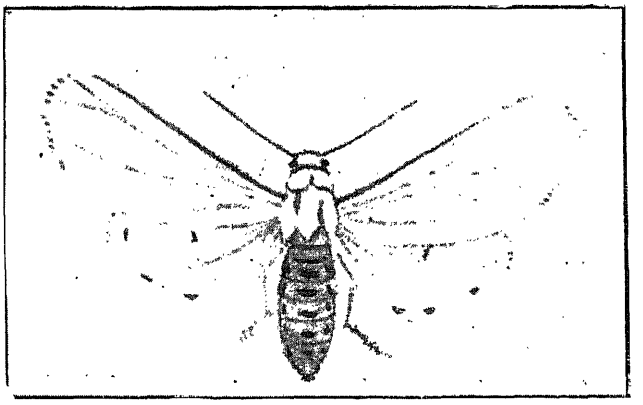
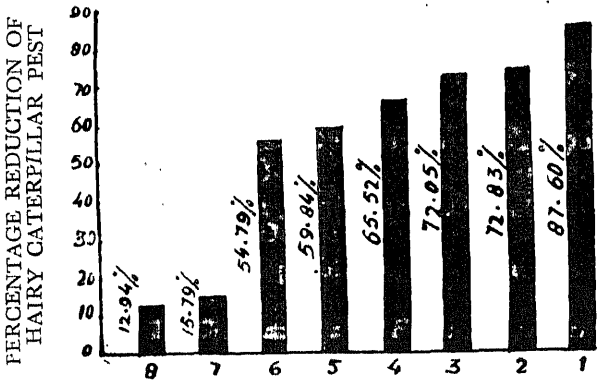


Fig. 5

Fig. 1 Eggs on a leaf.
Fig. 2 Caterpillar.
Fig. 3 Cocoon.
Fig. 4 Pupa.
Fig. 5 Moth.

the caterpillars the plot size in the layout was kept sufficiently big *i.e.*, 1/6th of an acre each. Those plots were separated from one another by a distance of 20 ft. to serve as gangway. Counts for the number of caterpillars present in 2'×2' area at each place, selected atrandom, were made at 20 places in each plot separately before the application of treatments. The observations after 24, 48, and 72 hours of the application of treatments were again recorded by counting the number of surviving caterpillars at 20 places in 2'×2' area at each place in an individual plot. There were eight treatments in the trial *viz.*, (1) Dusting with Geigy kutra dust @ 40 lbs. per acre, (2) Dusting with 20% BHC dust @ 40 lbs. per acre, (3) Dusting with 15% BHC dust @ 40 lbs. per acre, (4) Dusting with 10% BHC dust @ 40 lbs. per acre, (5) Dusting with 5% Basudin dust @ 40 lbs. per acre, (6) Dusting with 6% Heptachlor dust @ 40 lbs. per acre. (7 and 8) Control (No treatment). The results are represented in the following histogram :

PERCENTAGE REDUCTION OF HAIRY CATERPILLAR, *AMSACTA MOOREI* BUTL. AFTER 72 HRS.



TREATMENTS

CONCLUSION

The results achieved have clearly shown that dusting the crop with Kutra dust (Geigy) said to contain 15% Toxaphene + 5% DDT is most effective against the red hairy caterpillar pest closely followed by dusting with 20%, 15% and 10% BHC dusts.

The factor of attraction to light can be utilised and the farmers should be persuaded to use petromax lanterns and the moths thus attracted can be easily collected and killed by keeping kerosinised water in a vessel near the light.

THE FUNCTIONAL ANATOMY OF THE PITUITARY OF A FRESH WATER TELEOST, LABEO ROHITA (Ham.)

By.

H. A. KHAN

Department of Zoology, University of Lucknow

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INTRODUCTION

The structure of fish pituitary is basically similar in all classes of vertebrates. The general anatomy of the Teleost pituitary is well established and has been elucidated from time to time in the important works by Herrings (1908), Tinley (1911), Stendell (1914), Mathews (1936), Charipper (1937), Woodman (1939), Kerr (1942 *a* and *b*, 1948), Lee (1942), Potts (1942), Miller (1944), Green (1951) Scruggs (1939, 1951), Tampi (1953), Hoar (1957) and Pickford and Atz (1957). Das and Khan (1961) have given a brief resume of pituitary structure in fishes (with Indian examples) and attempted to standardise pituitary terminology as well as dosage. A majority of the work done by these authors is on the morphology and histology of the teleost pituitary. Atz (1953) and Barrington and Matty (1955) were able to differentiate two functional types of basophil (or cyanophil) cells. Matty and Matty (1959) investigated both the histology and histochemistry of some teleost pituitaries. The present investigation is an attempt to unravel the functional anatomy of a teleost pituitary by using latest methods and staining techniques, the fish used being the fresh water Carp *Labeo rohita* (Ham.).

MATERIAL AND METHODS

Fishes were killed by severing the head and the pituitary glands were fixed, attached to the floor of the skull, within a few minutes. The heads of some fresh fishes were also collected from the local market. The fixatives used were Bouin's picro-formol, formol-sublimate, Zenker's formol and Dawson and Friedgood-fluid and the following were the methods used for staining the sections of the pituitary :

(1) Azan method as modified by Scruggs (1939).

(2) Masson's trichrome stain.

(3) Periodic Acid-Schiff method. (McManus 1948 ; Pearse 1950 ; Purves and Griesbach 1951 and Elftman 1959).

(4) Aldehyde fuchsin with Orange G and Light green (Halmi 1952 ; Cameron and Stelle 1959).

(5) Aldehyde-thionin (Paget and Eccleston 1959, 1960).

Dawson and Friedgood-fluid and Azan method gave good results and was used for routine work. Paraffin sections were cut at 5, 8, and 10 micra. The combination of these methods provides a broad basis for the comparative functional study of the adenohypophysis more satisfactorily than any other method employed.

The hypophysis of *Labeo rohita* (Ham.) is a compact cylindrical structure situated ventral to the brain attached to the infundibulum by a short and broad pituitary stalk. The hypophysial recess is reduced and it does not extend much into neurohypophysis.

To avoid confusion the revised terminology used by Pickford and Atz (1957) has been mainly adopted. The gland is divided into a nervous component the *neurohypophysis* and a glandular component, the *adenohypophysis*. The adenohypophysis is further divisible by its histological characteristics into *pro-adenohypophysis* (=Pars anterior, partie folliculaire or anterior glandular region) ; *meso-adenohypophysis* (=transitional, Ubergangsteil or middle glandular region) and *meta-adenohypophysis* (=pars intermedia or posterior glandular region), the three parts of the glandular region being distinct and delimited into lobes in a number of fishes.

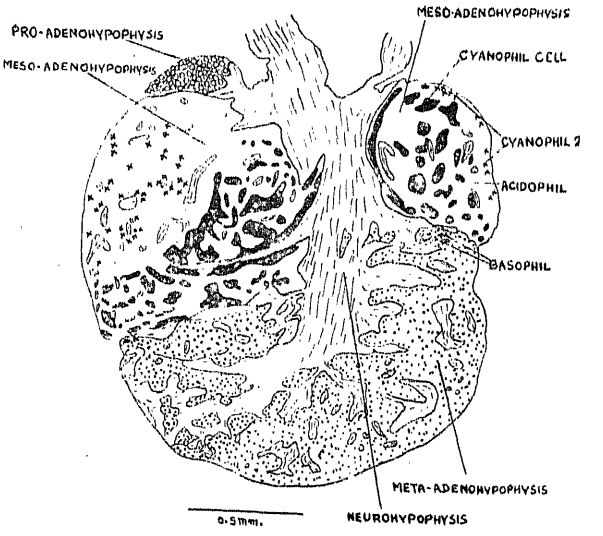


Fig. 1. A median sagittal section of the pituitary gland of *Labeo rohita* (Ham.). showing parts and distribution of various cell-elements (diagrammatic).

Neurohpopyhysis :

The pituitary stalk is contained into the adenohypophysis as a great trunk (the neurohypophysis) which sends out small branches into pro- and meso-adenohypophysis and the main trunk of the process continues into meta-adenohypophysis and there it arborizes (Text Fig. 1). The arborization of neurohypophysis in all the lobes of the adenohypophysis is regarded as an advanced feature when compared to its restriction in the meta-adenohypophysis alone (Charipper 1937). The neurohypophysis is composed of loosely arranged fibres among which nuclei of the neuroglia cells, often droplets, irregular patches of colloid-like material are present (Plate II A). Occasionally a few gladular cells are also seen

in the neurohypophysis. With Masson's stain most of the fibres of neurohypophysis react with red components and not with green showing their *glial* nature. There are irregularly shaped ependyma cells along with floor of the infundibulum, while the blood vessels are mainly seen as longitudinal trunks in the neurohypophysis. The colloid-like material in neurohypophysis is believed by Bock (1928), Buchmann (1940), Kerr (1940), Scruggs (1951), Sathyanesan (1958) and others to be a secretion which varies in amount with the breeding season.

Pro-adenohypophysis :

The *Pro-adenohypophysis* is a narrow plate of cells lying in the antero-dorsal part of the gland, containing light staining acidophil cells which have coarse granules in the cytoplasm, and average 8 micra in size. By Azan method of staining the cells take either the carmine or the orange G stain, depending on the degree of differentiation of the azocarmine. The cell outlines are in most cases invisible. (Text Fig. 2 and Plate I B). A few chromophobes are always present. Almost nothing is known about the function of this region.

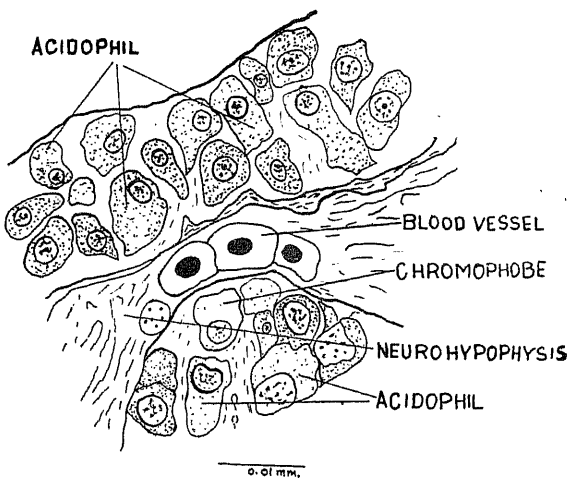


Fig. 2 L. S. Pro-adenohypophysis to show cell types.

Meso-adenohypophysis :

The *Meso-adenohypophysis* is made up of almost entirely interspersed masses of large and deeply staining basophil and acidophil cells. There are two types of acidophils *i.e.* (*a*) fuchsinophils and (*b*) orange G cells. The acidophils average 13 micra in size. The basophils (cyanophils) may also be differentiated in two main functional cell types, by application of specific staining methods, which have been indentified as *Gonadotrophs* and *thyrotrophs*, (Text Fig. 1). One type of basophil (Cyanophil cell type 1) is of variable size and shape, and ranging from a small round cell to one that is irregularly shaped and averages 15 micra. The nuclei of these basophil cells are usually round or oval, although some variations in shape may occur. The cytoplasm of these basophils (cyanophil type 1) is composed of fine granules which colour brightly with Periodic Acid Schiff (PAS) and Gomori (AF) stain. Many of these cells may also show vacuolation. In addition to granules these basophils contain globules or spheres which vary greatly in size and number, stain very light orange and are thus acidophilic in nature

Scruggs (1951) believed these acidophilic globules to be identical with the acidophilic droplets which are found in neurohypophysis. Many authors (Bock 1928 Buchmann 1940 and Kerr 1940) refer to this material as secretion product of the gland parenchyma of the hypophysis. These basophils (cyanophil type 1) are regarded as gonadotroph and are the source of gonadotrophin (Text Fig. 3, Plate II A and Plate III A).

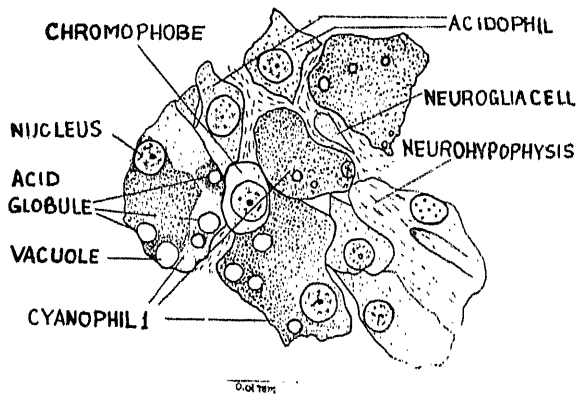


Fig. 3. L. S. Meso-adenohypophysis showing cyanophil cell type (1).

The other type of basophils (cyanophil cell type 2) have a tendency to lie towards the periphery, and are the thyotrophs. They stain more lightly with aniline blue than do the gonadotrophs and their contents seem more tenuous and less-defined. Their nuclei are large or rounded. These cells are found singly or in groups scattered towards the periphery and individual cells with similar features may be seen lying in other parts of meso-adenohypophysis (Text. Fig. 1). These basophil (cyanophil cell type 2) average 12 micra in size and are regarded as Thyrotroph as a source of thyrotrophin (Text Fig. 4, Plate II B and Plate III B).

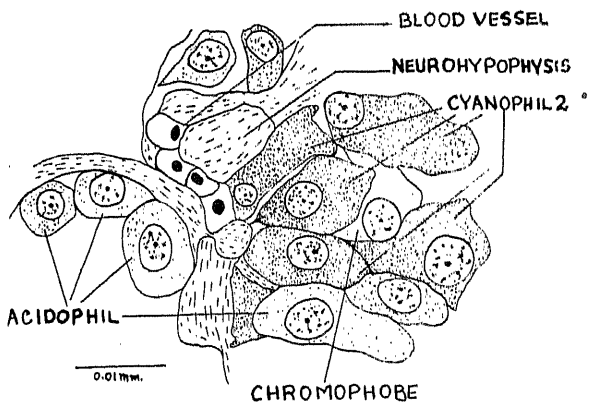


Fig. 4. L. S. Meso-adenohypophysis showing cyanophil cell type (2).

These cells are PAS positive, AF positive and Aldehyde thioninpositive. Thyrotrophs are reported to be towards the periphery (Atz 1953), scattered and infrequent (Oliverean 1954*b*) and in conspicuous groups lying close against the branches of neurohypophysis (Barrington and Matty) in the meso-adenohypophysis of *Astyanax mexicanus*, *Salmo salar*, and *Phoxinus phoxinus* respectively. They lie towards the periphery of meso-adenohypophysis in *Labeo rohita*, but some thyrotrophs are also present in the antero-dorsal half of the meso-adenohypophysis (Text Fig. 1). These acidophilic globules are generally not present in these cells, but their occasional presence has not yet been completely ruled out.

In addition to these two well defined types of cyanophil cells, there are smaller cells averaging 6 micra in size (cyanophil type 3) which are stained lightly by PAS and AF (after oxidation with potassium permanganate solution). They have a nucleus which is contracted. These cells lie scattered among the deeply staining cyanophil cell type 1 (Plate III A). Their exact nature is not known and at present they cannot be easily assignable to either of the two main functional types. However Barrington and Matty (1955) believed that some of these cells are probably resting cells from which larger and active cells are recruited and others may be exhausted old cells.

The chromophobes are a few and are interspersed singly or in clusters among basophils and acidophils. The blood vessels are present as a capillary network in this region. Maximal development of basophils in meso-adenohypophysis is usually associated with maturation of gonads in *Labeo rohita*.

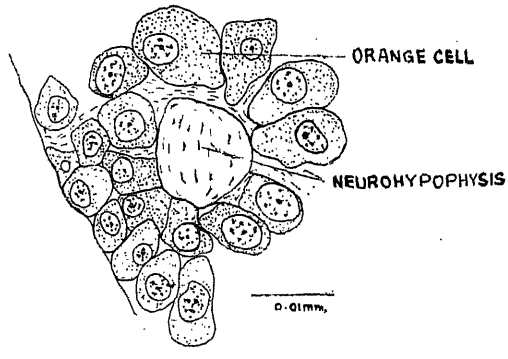


Fig. 5. L. S. Meta- adenohypophysis showing Orange Acidophil cell.

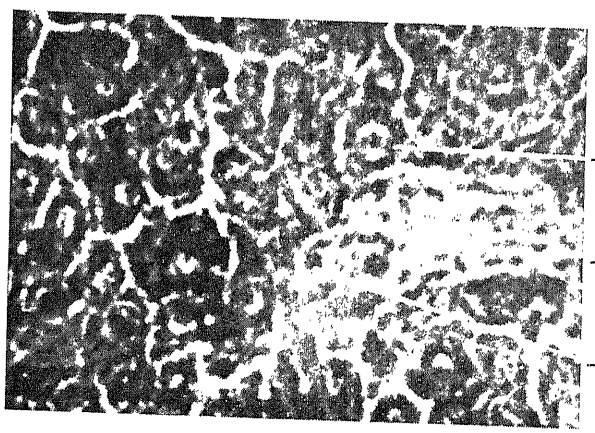
Meta-adenohypophysis :

The *meta-adenohypophysis* is the largest component of the glandular region and appears as a cone-like region, with its apex directed ventrally, which completely surrounds the arborized portion of the main nervous penetration (neurohypophysis). This region also contains a few deeply staining basophils averging 10 micra, resembling those of meso-adenohypophysis and lying adjacent to the latter (Text Fig. 1). There is a massing of ovoidal orange cells (Text Fig. 5 and Plate III C), averaging 8 micra, and with distinct granulated cytoplasm, in clusters surrounding the branches of neurohypophysis. These cells may be found singly or in clusters scattered throughout the meta-adenohypophysis, but are concentrated along nervosal branches toward the periphery and more towards the apex of

PLATE I

A

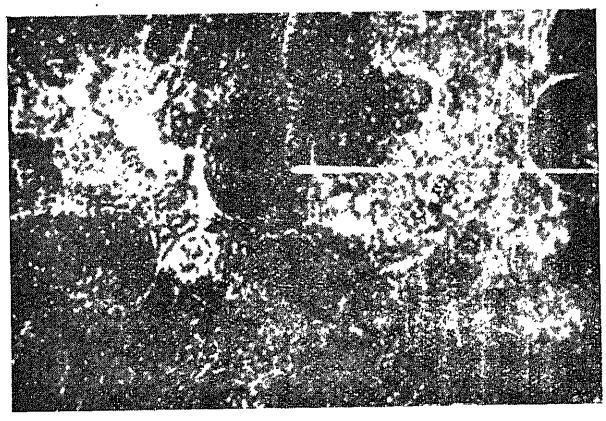
B



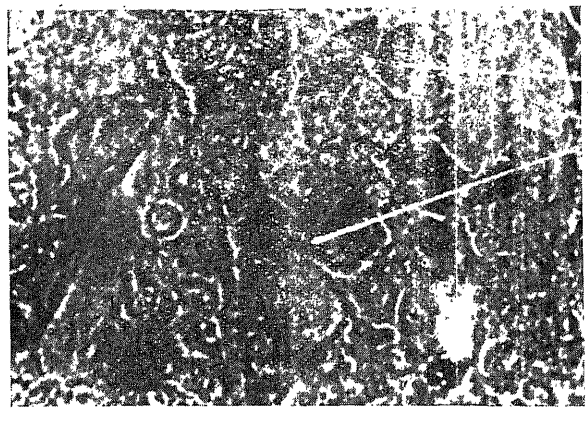
A. L. S. Neurohypophysis × 800 (Azan preparation).
B. L. S. Pro-adenohypophysis × 800 (Azan preparation).

PLATE II

A

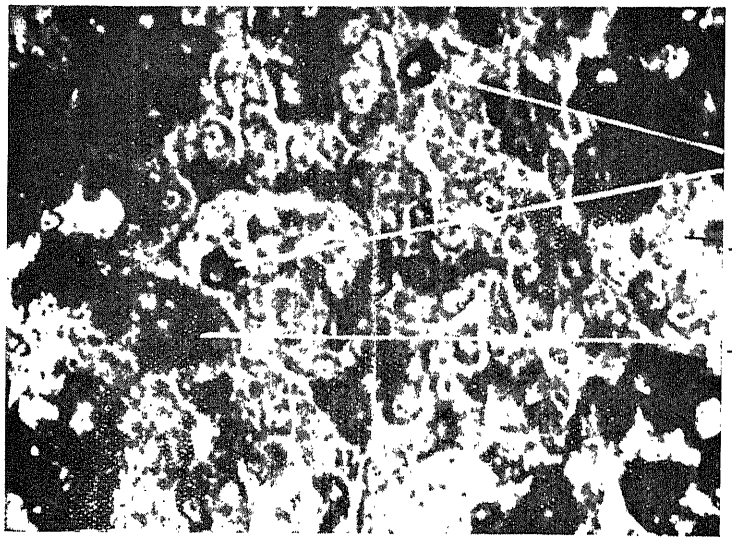


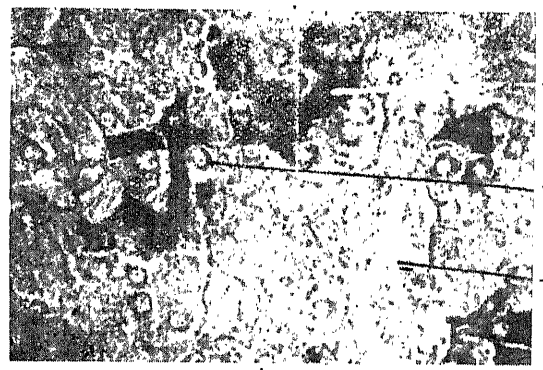
B

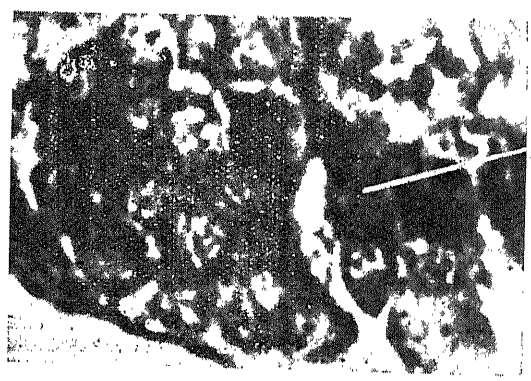


A. L. S. Meso-adenoh ypophysis showing Cyanophil Cell type (1) × 800 (PAS preparation).
B. L. S. Meso-adenohypophysis showing Cyanophil Cell type (2) × 450 (PAS preparation).

PLATE III







A. L. S. Meso-adenohypophysis showing Cyanophil types (1) & (3) × 1000 (AF with permanganate Oxidation).

B. L. S. Meso-adenohypophysis showing Cyanophil type (2) × 450 (AF with permanganate Oxidation).

C. L. S. Meta-adenohypophysis showing Orange Acidophils × 1000 (AF with permanganate Oxidation).

the gland. The chromophobes appear like naked nuclei due to their scanty non-staining cytoplasm. The branches of neurohypophysis jutting into meta-adenohypophysis have a fair amount of blood vessels and colloid material. The meta-adenohypophysis is functionally concerned with the elaboration of melanophore dispersing hormone (Pickford and Atz 1957). Kent (1960) stated "erythrophore dispersing and melanophore dispersing factors in the minnow pituitary are present in both the anterior and posterior pituitary but significantly higher concentration in the posterior pituitary." He thus supports the view of Pickfard and Atz (1957). The deeply staining basophils in the meta- lying adjacent to meso-adenohypoyhysis, appear to be the same as meso-adenohypophysis in *Labeo rohita*. Possibly these are real gonadotrophs that have migrated from the meso- in which case the meta-adenohypophysis has a gonadotrophic harmone as well.

DISCUSSION

The pituitary of *Labeo rohita* is attached to the brain by a distinct stalk and consists of a nervous region the neurohypophysis, and a glandular one, the adenohypophysis. The three zones of adenohypophysis are distinct.

The neurohypophysis does not contain of oval cavities or spaces like those described in this lobe in *Anguilla anguilla*, and *Pleuronectes* sps. (Kerr. 1942).

The pro-adenohypophysis consists of acidophils and chromophobes. The occurence of a few basophils (Scruggs 1939, 1951) or lilac basophils (Sathyanesan 1958) has not been observed in *Labeo rohita*. The hypophysial cavity described in the pro-adenohypophysis of *Salmo trutta*, *Esox lucius*, *Anguilla anguilla*, (Kerr 1942); *Chanos chanos* (Tampi 1951, 1953); *Hilsa ilisha*, *Engraulis telara*, *Gadusia chapra* and *Pangasius pangasius* (Sathyanesan 1960) is totally absent in *Labeo rohita*.

The attempt to find the existence of the two main types of cyanophil cells in the meso-adenohypophysis by employing different specific staining techniques has been successful. The use of Aldehyde Fuchsin (AF) without permanganate oxidation by Halmi (1952), Purves and Griesbach (1951, 1957), Elftman (1959*a*) in the studies of mammalian pituitary and by Atz (1953), Barrington and Matty (1955), Sokol (1955) and Matty and Matty (1959) in those of fish pituitary distinguish cyanophil 2 from cynophil 1 in staining the former only, while the latter remains unstained. If the sections are stained for a prolonged time the cyanophil 1 may take up slight stain but the reaction of the type 2 remains distinctive by its brightness and clarity. When sections of pituitary are subjected to permanganate oxidation (Elftman 1959 *c* and Cameron and Stelle 1959) cyanophils 2 (thyrotrophs) still stain, but now the gonadotrophs also respond. Thus by parallel oxidation and the other without it, is possible to differentiate gonadotroph as well as thyrotroph.

Neither Atz (1951) nor Sokol (1955) were able tinctonally to distinguish between gonadotrophs and thyrotrophs. Barrington and Matty (1955) were able to obtain differentiation between two main types of cyanophil cells by means of Gomori AF method. Pickford and Atz (1957) believed that the probable cause of Atz's failure to obtain with Gomori AF stain is attributed in the fixattves they employed or in overstaining. My experience has shown that all the qualiies oi basic fuchsin available do not give equally satisfactory results, and past failures to differentiate between Cyanophil 1 and Cyanophil 2, may be due to this.

Catchpole (1949), Herlant (1949), Purves and Griesbach (1951), Atz (1953), Barrington and Matty (1955) and Matty and Matty (1959) have demonstrated that PAS reaction can be applied to the functional differentiation of cell types in meso-adenohypophysis. The probability that cyanophil cells are involved in the

secretion of glyco or muco protein harmones is indicated by the fact that both types of cyanophils are PAS positive and can only be differentiated in granule size, their distribution and staining intensity. These results are in confirmation with those of Atz (1953) and Barrington and Matty (1955). The AF possitive cells which are regarded to secrete TSH are found in particlar abundance at the boundary between pro-adenohypophysis and Meso-adenohypophysis ; and individual cells of similar features may be seen scattered also where in meso-adenohypophysis of the pituitary of *Labeo rohita.*

It has been observed during the course of the present studies that during breeding season when gonadotrophs are at their maximum activity, there is a differential staining of all types of cyanophil cells. At other period of the year there is very little difference in their staining intensity, showing a functional bias.

The third type of small cyanophil cells (average 6 micra) are also seen lying scattered among the cells of meso-adenohypophysis. These cells are stained lightly with PAS and AF (with potassium permanganate oxidation) and aldehyde thionin. A final opinion about the nature and division of small cyanophils into two types (like larger ones) is reserved till further investigations have been done.

This is probably the first record of all the 3 types of cyanophils in the meso-adenohypophysis of fish pituitary being stained by aldehyde-thionin. But it has not been possible to stain specifically both gonadotrophs and thyrotrophs simultaneously as Paget and Eccleston (1960) have done in the rat and dog pituitary, by superimposition with PAS.

The meta-adenohypophysis contains a few occasional basophil cells which are PAS positive, AF positive (with permanganate oxidation) and Aldehyde thionin positive. But these cells always lie adjacent to the meso-adenohypophsis. The acidophils of this region also stain weakly with PAS. Matty and Matty (1959) stated that amphiphils in meta-adenohypophysis of some teleost pituitary were PAS positive (somewhat weakly) and may correspond to the type 2 cell of the other species.

The large number amphiphil cells of *Scarus croicensis* and *Pseudoscarus guacamaia* (Matty and Matty, 1959) in meta-adenohypophysis are also *problematical.* If these cells correspond to the acidophils of Kerr 1942 ; Scruggs 1951, and Sathyanesan 1958, (who did not attempt the PAS test) they should be called acidophils only. But as these lightly staining cells are PAS positive in both *scarus* and *Pseudoscarus,* and as I have found them PAS positive in *Labeo,* the evidence for the existence of a third type of cell, besides basophils and acidophils, may be accepted now ; and these may be called amphiphils after Matty and Matty (1959).

SUMMARY AND CONCLUSIONS

1. An historical account of the study of teleost pituitary has been given.
2. The histology of the pituitary has been described by different staining techniques.
3. The neurohypophysis is composed of loosely arranged fibres among which lie nuclei of neurolgia cells, droplets and irregular patches of colloid like material. It also contains a fair amount of blood vessels and a few glandular cells.
4. The Pro-adenohypophysis consists of :
   (*a*) Acidophil cells which make up most of the pro-adenohypophysis.

(*b*) Chromophobes which are few in number. The ramifications of neurohypophysis contain only small number of blood vessels. Basophil cells have not been found.

5. The meso-adenohypophysis contains :

(*a*) Basophils which are of 3 kinds :

(*i*) Deep staining basophils or cyanophil cells type 1.

(*ii*) Lightly staining basophils or cyanophil cells type 2.

(*iii*) Small basophil or cyanophil cells type 3.

(*b*) Deeply staining acidophils.
(*c*) Chromophobes cells.

(*b*) The meta-adenohypophysis consists of :

(*i*) Deeply staining basophil which are few in number and lie adjacent to the boundary of meso-adenohypophysis.

(*ii*) Light staining acidophils which usually border the branches of neurohypophysis (possibly amphiphils of Matty and Matty, 1959).

(*iii*) Chromophobes.

6. Application of PAS stain to the pituitary of *Labeo rohita* has shown that two functional cell types of cyanophil can be defferentiated from each other by the staining intensity, difference in granule size and by their distribution. Small bosophils which may be regarded as a third type of cyanophil are also PAS positive. All these three types of cyanophils are stained by aldehyde fuchsin and Aldehyde-thionin (with permanganate oxidation) and cyanophil type 2 (which is regarded as thyrotroph) responds to Aldehyde-fuchsin. The acidophils of meta-adenohypophysis are also PAS positive but very weakly stained.

ACKNOWLEDGMENTS

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CHEMICAL CONTROL EXPERIMENTS IN *PUCCINIA PENNISETI* ZIMM.

By

G. G. DALELA*

Botany Department, Agra College, Agra

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INTRODUCTION

The method of testing chemicals in the laboratory for their fungicidal property through studying their effect on germination of fungal spores under controlled conditions has been found to be a fairly reliable criterion for evaluating the same under field conditions. The preliminary laboratory tests are helpful both in eliminating inactive compounds and for comparing the activities of different compounds under identical conditions.

In a laboratory assay of certain fungicides, sulpha-drugs, antibiotics and synthetic phytohormones on their efficacy in inhibiting uredospore germination of *Puccinia penniseti* Zimm. (Dalela and Sinha 1959), it was found that some synthetic phytohormones were most effective and the antibiotics the least so, while the sulpha-drugs and the fungicides were only mild in their action. Considering the ED 50 dose, 2, 4–D and NAA proved toxic at 10 ppm ; sulphadiazine, IAA and Dithane Z–78 at 100 ppm. and sulphathiazole, sulphaguanidine, streptomycin, fytolan, perenox and coppesan at 1000 ppm.

In this investigation glass house experimental trials were, therefore, made to see if the results of germination studies can be applied in controlling rust development. The effect of one representative of each group of chemicals *viz.* sulpha-drugs, antibiotics, fungicides and synthetic phytohormones on the disease development was studied by spraying the foliar parts of host plants and also by applying the chemical in the soil along with irrigation water.

METHOD AND MATERIAL

A.—Spray of the foliar parts.

Seedlings of *bajra* (Agra Local variety of *Pennisetum typhoides* Stapf and Hubb.) were raised in 4" earthenware pots in a seedling house, and at 2–leaf stage the pots were transferred to the glass house under the usual aseptic conditions. The seedlings were then sprayed with 2, 4–D (synthetic phytohormone) in 10 ppm, sulphadiazine (sulpha-drug) in 100 ppm, streptomycin (antibiotic) in 1000 ppm and coppesan (fungicide) in 1000 ppm concentrations. The concentration of each chemical for spraying was determined on their ED 50 values. The spray was administered at different time intervals as follows :

Treatment 1 (T1) Seedlings sprayed 24 hours before inoculation.

Treatment 2 (T2) Seedlings sprayed 3–4 hours after inoculation.

Treatment 3 (T3) Seedlings sprayed 24 hours after inoculation.

Control (C) Unsprayed.

*Present address : Junior Specialist, Plant Pathology Section, Department of Agriculture, Rajasthan, Udaipur.

Equal amounts (20 c.c.) of the solution were sprayed on the plants of each set uniformly till it started dripping down from the leaves.

B.—Soil applications.

50 c.c. of the solutions of each of the chemicals were added to the irrigation water of the pots three days before inoculation. The pots, in both the set of experiments, were inoculated following the usual method of rust infection. Care was taken to keep the amount of the inoculum constant in each case. Eighteen replications for each treatment were kept (3 pots with 6 seedlings in each). The rust development was noted two weeks after inoculation by counting the total number of pustules per leaf and the total number of pustules per unit area (1 sq. cm.). The data were subjected to statistical analysis following the simple 'analysis of variance' method. The critical difference at 5% level is given along with the means wherever significance was observed.

RESULTS

TABLE 1

Effect of spray of chemicals and of adding them to the soil, on rust development. (Mean of 18 values)

	Observations	Treatments C	T1	T2	T3	C.D.
A.—Spray of the foliar parts.						
Spray with 2, 4–D (10 ppm)	No. of pustules per leaf	29·89	31·83	16·72	17·61	9·08
	No. of pustules per unit area	9·33	10·96	8·33	8·43	—
Spray with sulphadiazine (100 ppm)	No. of pustules per leaf	92·83	62·50	44·94	62·50	20·92
	No. of pustules per unit area	27·43	15·89	12·39	18·51	6·42
Spray with streptomycin (1000 ppm)	No. of pustules per leaf	63·06	44·89	27·94	49·33	16·66
	No. of pustules per unit area	18·69	7·78	7·34	13·19	4·34
Spray with coppesan (1000 ppm)	No. of pustules per leaf	59·67	61·05	57·22	61·89	—
	No. of pustules per unit area	15·60	15·14	13·97	14·99	—
		C	2, 4-D	Sulpha-diazine	Strep-tomycin	C.D.
B.—Soil applications.						
	No. of pustules per leaf	52·67	59·56	67·39	79·67	—
	No. of pustules per unit area	16·81	18·78	19·67	15·14	—

A.—Spray of the foliar parts.

Influence of 2, 4–D : 2, 4–D resulted in decreasing the infection as indicated by the number of pustules per leaf as well as per unit area when applied 3–4 hours after inoculation or 24 hours afterwards. Spraying 24 hours before inoculation does not apparently have any effect.

Influence of sulphadiazine : Sulphadiazine appears to give best results when the seedlings were sprayed 3–4 hours after inoculation, although some check in rust development is also obtained when sprayed 24 hours before or after inoculation.

Influence of streptomycin : Streptomycin behaves like sulphadiazine. The maximum control of the infection in terms of total number of pustules is achieved by spraying the antibiotic (1000 ppm) 3–4 hours after inoculation. Effective inhibition of rust development, on the basis of the number of pustules per unit area, is obtained equally by spraying 24 hours before inoculation or 3–4 hours after inoculation.

Influence of coppesan : Since no significant differences are observed between the control and the experiments, coppesan is ineffective.

B.—Soil applications.

Addition of the different chemicals to soil three days before inoculation seems to have no influence on the number of pustules per leaf or per unit area.

SUMMARY

Spraying with 2,4–D (10 ppm) 3–4 hours or 24 hours after inoculation decreased rust infection in *bajra* rust. Sulphadiazine (100 ppm) and streptomycin (1000 ppm) are effective when sprayed 3–4 hours or 24 houre after inoculation or 24 hours before inoculation. Spraying 3–4 hours after inoculation gives the best results. Coppesan (1000 ppm) is not effective. Soil application of 2, 4–D, sulphadiazine and streptomycin does not produce any effect.

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THE PROBLEM OF SOIL EROSION IN SOME PARTS OF KASHMIR HIMALAYAS

By

J. S. SINGH *and* M. K. WALI

Central Botanical Laboratory, Allahabad

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INTRODUCTION

The term soil erosion according to Fox (1950) covers 'a wide range of physical and chemical actions such as removal of soluble matters, chemical changes, disintegration by frost or rapid changes of temperature, attrition by dust charged winds, scouring by silt laden currents, alternate impact and suction by storm waves, land slides and so on.' Erosion is partly a natural phenomenon useful to man by which soil is formed from rocks. But accelerated erosion due to misuse of the resources of land, water and soil is today one of the most difficult and pressing problems confronting man himself. Both engineering and biological methods have been used but erosion is still without a plausible check. Vast tracts of fertile land are rendered useless in the wake of industrialisation and development. Erosion has posed a serious challenge in the United States, Japan, South and North Africa, North China, Mesopotamia, India and numerous other countries. In India we are aware of the "advancing deserts" of Rajasthan and erosional losses, floods etc. in other parts of the country.

The problem has received the attention of foresters, ecologists, soil scientists and engineers only recently. The erosion of Siwaliks has been studied (Glover and Hamilton, 1935 ; Gorrie, 1951) and various methods to check it have been suggested. Recently Puri (1949, 1954) has analysed the problems from different angles and suggested that to check erosion losses of the soil the escarpment must be kept under tree vegetation. The Central Arid Zone Research Institute is attempting to check erosional losses in Rajasthan in collaboration with UNESCO. The Indian Council of Agricultural Research, especially the Wasteland Reclamation Committee, is giving attention to this problem in collaboration with the state forest and agriculture departments.

In connection with our ecological studies on the vegetation of the Kashmir Himalayas, some observations were made on this problem. The places studied were : Tangmarg, Gulmarg, Khilanmarg embracing the Ningal Nullah Zone and Baramulla district in South Kashmir ; Banihal, Quazigund and Shopian in North Kashmir and Kud, Batote and Ramban valley in the Jammu province.

Causes of erosion :

As in the Hoshiarpur Siwaliks (Glover and Hamilton, 1935 ; Puri, 1949) the accelerated erosion here also, seems to be the result of a number of factors, acting singly or collectively, such as the disturbance in the original cover of vegetation, excessive grazing, the presence of very undesirable forest biota, exposure to drought, excessive snowfall, etc. Mention may here be also made of the most important factor—the malpractices brought in by man himself.

Diforestation is the commonest factor at play here, which is responsible for causing erosion. Ruthless fellings have exposed soils to the direct effect of rain,

snow and drought and soil deterioration and erosion, of the gully and sheet types has set in over extensive areas in Kashmir. This has assumed serious proportions at many places in Gulmarg, Baramulla and Banihal and the extent of erosion increases as each day passes on. One dreads that a time may come when the whole area will not only be barren and devoid of any vegetation but may also not have any layer of soil, unless steps are taken now to check it.

The socio-economic conditions of the hilly tribesmen are such that they are in the main dependant on the nearby forests for their daily requirements. The natives collect even the forest litter from the forests for fuel and manure. The removal of litter, which is the only source of mineral return from the plant to the soil, depletes the soil of its richness. The soil is exposed, becomes dry, loses porosity and gives way to erosion.

Grazing is yet another destructive factor for the soil. It is a practice for the nomadic tribes to come with their herd of cattle and sheep during the summer months in these forests, since by far the large part, grazing is permitted. Whyte (1957) writes "the control of fluctuating grazing was made the responsibility of the forest department in 1939, but this appears to have had little effect and the problem is as acute as ever." Kashmir had admitted the maximum number of grazing animals, the number shooting up to 5,126,400 in 1947–48. The net area of forests under the control of forest department open to grazing is 10,525 sq. miles and grazing incidence expressed as number of acres per animal is 1·3, which is very inadequate. Conifer forests in this valley are remarkably pure having little or no broad leaved species. There are no or very less Oaks, Rhododendrons and laurels. The deciduous broad leaved species are also fewer and occur scattered in gullies and nallahs. There is no proper natural water conservation in pure coniferous forests. Lack of water conservation also promotes erosion.

Amongst the natural factors affecting erosion, surface geology, formation of rocks, are important ones for consideration.

Flood plain alluvium, moraines, etc. are easily affected by erosion as seen both in North and South Kashmir. Unstable rocks erode easily as seen at many places on way from Jammu to Srinagar. Heavy precipitation causes landslides and promote sheet erosion in surface deposits.

Methods to check erosion :

The control of erosion, when it has already assumed such large dimensions is not easy and in many cases not possible. It is always better to 'nip the evil in the bud' than allow this menace to grow. This too, cannot be acquired by a single means. Stanley A. Cain (1959) gave eight measures 'that comprise conservation practices,' *viz.* Preservation, Restoration, Maximization, Beneficiation, Rentilization, Substitution, Allocation and Integration. Of these, according to him, Preservation, Restoration and Integration involve general ecological principles, while the others do not use the ecological approach directly.

Preservation :

This connotes, in Cain's own words : "the protection of certain natural areas from consumptive areas." The excessive felling and cutting of trees should be thus minimized as far as possible. The practice of collection of all forest litter by natives and nomadic tribes may probably be best checked by education or legislation.

Since grazing in all the areas under study, cannot be completely stopped, a system of restricted and rotational grazing may be helpful. The area open to grazing for some time has to be closed for the following years to facilitate forest regeneration and maintain thick ground flora.

Restoration :

..."repair of the biosphere, return of the eco-system to homeostasis".....We can safely put in here, the best means to check soil erosion, the afforestation. Before that the role of vegetation as a factor to check erosion is to be clearly understood. Lutz and Chandler (1946) cite the following points in support of the vegetational check of erosion : (*i*) infiltration of water is favoured due to high soil porosity under vegetation ; (*ii*) surface accumulation of organic matter increases the water holding capacity of soil, (*iii*) root systems of the vegetation hold the soil mechanically, and (*iv*) protection against wind is afforded. The forest vegetation also shields the soil from direct efforts of drought, snow and rain.

State forest department has already started this practice though in very restricted areas, and it has met with good success. Forest compartments 72 and 73 in Baramulla region afford good examples. In compartment 72, mixed planting of *Pinus*, *Cedrus*, and other species has been done. The plants are thriving well and have checked erosional losses of soil to a great degree. As against this, we have compartment 73, just opposite to compartment 72, where plantations have not been made and soil is actively eroding.

Another example is afforded by Shankaracharya hills near Srinagar which are heavily eroded. Forest department took up the planting of coniferous species like *Pinus wallichiana*, *P. roxburghii*, *P. sylvestris*, *P. insignis*, *P. gerardiana*, *Cupressus arizonica*, *C. sempervirens*, *Juniperus* sp., *Cedrus deodara* and broad leaved species like *Aesculas indica*, *Fraxinus* sp., *Juglans regia*. These have checked some erosion.

The problem of afforestation in itself is a complicated one. The most important is the selection of suitable species for a particular area. This can be accomplished by dividing the whole area into different catchment zones depending upon the climate, soil and biota and suitable species for each zone should be selected from those growing there. Emphasis here should be, however, on the successional trends of the vegetation. Lutz and Chandler (1946) state that the agent most effective in preventing accelerated erosion in any region is the climax vegetation. However, the well-stocked communities representing stages of succession near climax, also to a great extent help in preventing erosions. Since Oaks are the climax vegetation all over the Himalayas, planting of Oaks and other broad leaved species is suggested in areas where Oaks are absent or their growth is less. This would serve a dual purpose. The broad leaved species would help in proper water conservation in the coniferous forests.

Afforestation has been helpful also in checking erosion of unstable rocks, probably by checking the seepage of water (Puri, 1951).

The erosion in cultivated soils due to primitive cropping practices can be best checked by introducing advanced systems, *e.g.* proper terracing of fields, making of furrows across the slope, etc.

Construction of temporary check dams is very helpful in checking surface runoff of the soil due to heavy precipitation and steep slopes.

To summarize, the following species are suggested for general afforestation out of which selection could be made in accordance with particular needs of the

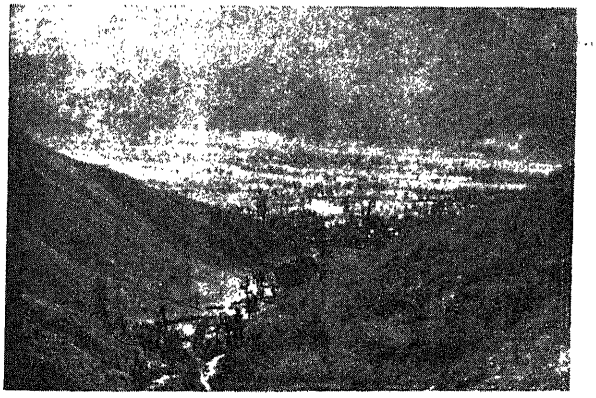

Fig. 1

Fig. 2

Fig. 3

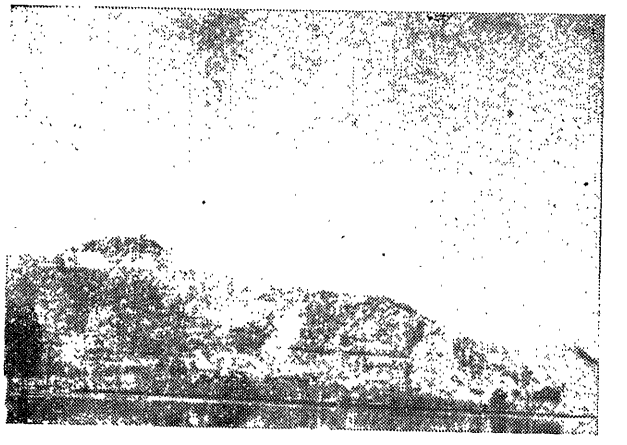

Fig. 5

Fig. 4

Fig. 1. Showing the afforested comptt. 72, Baramulla against the bare comptt. 73, showing signs of erosion.

Fig. 2. Showing washing away of surface soil (sheet erosion) due to lack of proper vegetal cover, Gulmarg.

Fig. 3. Showing gully erosion, Baramulla.

Fig. 4. Showing cultivation in a forest area, a neglect of proper terracing and check which enhances gully erosion.

Fig. 5. Afforested Shankracharya hills, a successful effort to check erosion.

areas. The list has been based on the observations on the vegetation of Kashmir and adjacent areas in the Western Himalayas.

Altitude M.	Habitat	Species
3630–4090	Rocky substrata and Glacial moraines	*Juniperus communis* *Juniperus squamata* *Lonicera angustifolia* *Rhododendron campanulatum* *R. anthopogon* *Rosa microphylla*
2180-3630	Glacial moraines	*Abies pindrow* *Betula utilis* *B. cylindrostachya* *Lonicera angustifolia* *Pyrus foliolosum* *Quercus semecarpifolia* *Rhododendron campanulatum* *Rosa microphylla* *Salix denticulata*
2270–2180	Glacial moraines	*Abies pindrow* *Acer caesium* *A. piclum* *Betula cylindrostachya* *Juglans regia* *Lonicera angustifolia* *Picea smithiana* *Prunus cornuta* *Quercus semecarpifolia* *Rhododendron arboreum* *Salix lindleyana* *S. wallichiana* *Skimmia laureola* *Taxus baccata*
	River beds and flood plain deposits	*Aesculus indica* *Alnus nitida* *Betula cylindrostachya* *Juglans regia* *Salix lindleyana* *S. wallichiana*
	Abandoned cultivated fields	*Indigofera gerardiana* *Pinus wallichiana* *Rosa macrophylla*
	Rocky soil	*Corylus colurna* *Lyonia ovalifolia* *Pinus wallichiana* *Quercus dilatata* *Rosa macrophylla* *Viburnum nervosum*

Altitude M.	Habitat	Species
1670–2270	Flood plain deposits	*Acer caudatum* *Cedrus deodara* *Juglans regia* *Populus alba* *Populus nigra* *Salix wallichiana* *Platanus orientalis* *Pyrus communis* *P. pashia* *Quercus incana* *Parrottia jacquemontiana*
	River beds and near nullahs	*Aesculus indica* *Rhus chinensis* *R. cotinus* *Ulmus wallichiana*
	Abandoned cultivated fields	*Pinus wallichiana*
	Rocky soil	*Celtis alpina* *Fraxinus excelsior* *Ilex dipyrena* *Litsaea umbrosa* *Parrottia jacquemontiana* *Pinus wallichiana* *Quercus incana* *Rhododendron arboreum*
910–1670	Quartzite rocks	*Pinus roxburghii* *Quercus incana*
	Also on limestone	*Woodfordia fruticosa* *Skimmia laureola*
	Near river banks and nullahs	*Albizzia lebbek* *A. procera* *Cedrela serrata* *Cinnamomum tamala* *Platanus orientalis* *Pyrus pashia* *Rhus cotinus* *Rhus chinensis* *Xanthoxylum alatum*

Further down, species of ***Albizzia***, ***Anogeissus latifolia***, ***Acacia modesta***, ***A. catechu***, ***Bauhinia purpurea***, ***Dalbergia sissoo***, ***Olea cuspidata***, ***Salmalia malabarica*** and ***Syzygium cumini*** may be planted with success.

ACKNOWLEDGEMENTS

The authors express their gratitude to the Chief Botanist, B. S. I., for facilities and Dr. G. S. Puri, Director, Central Botanical Laboratory, Allahabad, for criticism and suggestions. Mr. M. K. Muthoo, Asstt. Conservator of Forests I/c Grazing-Cum-Erosion Survey, Kashmir, accompanied the authors to most of the places and M. K. W. specially wishes to record his grateful thanks to him.

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A NEW SPECIES OF THE GENUS *GLOSSODIPLOSTOMUM* DUBOIS, 1932 OF THE FAMILY DIPLOSTOMIDAE POIRIER, 1886

By

R. K. MEHRA

Zoology Department, University of Allahabad

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Dubois in 1928 described a parasite obtained from Plongeon in Neuchatel under the common genus *Hemistome* as *Hemistome glossoides*. In 1932 he created the genus *Glossodiplostomum* for this species and renamed it as *Glossodiplostomum glossoides* (Dubois, 1928). Vidyarthi (1938) described two new species *Glossodiplostomum hieraetii* and *Glossodiplostomum buteoides* from *Hieraaetus fasciatus* (Vieill.) and *Buteo rufinus* Rupp. respectively. Dubois (1938) in his "Monograph on Strigeida" considered both the species created by Vidyarthi to be identical and even doubted whether they would come under the genus *Glossodiplostomum* Dubois, 1932. Bhalerao (1942) created the genus *Glossodiplostomoides* and Dubois (1944) created *Pseudodiplostomum* for the species described by Vidyarthi ; the former genus is recognised on the basis of priority with genotype *Glossodiplostomoides hieraetii* (Vidyarthi, 1938) Bhalerao, 1942. Therefore, the only species belonging to *Glossodiplostomum* is *G. glossoides* (Dubois, 1928) Dubois, 1932. In this paper is described a new species of the genus *Glossodiplostomum* from the Indian darter *Anhinga melanogaster* Pennant, 1769.

Glossodiplostomum duboisilla, n. sp.

Only one spceimen of this species was obtained from the intestine of a snake-bird *Anhinga melanogaster* captured at Phulpur near Allahabad. The parasite appears to be very rare because out of about twenty birds examined, at different times of the year, only one yielded a single specimen which is quite mature and shows all the morphological details.

The worm measures 1·2 mm. in length and 0·3432 mm. in maximum breadth in the region of the holdfast organ. It is tongue shaped and not divided into two distinct body parts. The indistinctly demarcated anterior part of the body extends posteriorly upto the anterior testis. It is expanded posteriorly having the anterior end narrowest and maximum breadth just at the middle of the holdfast organ. The posterior or hinder body is conical and contains the testes, a portion of vitellaria and genital atrium. The anterior end of the body is indistinctly trilobed having round the oral sucker, measuring 0·053 mm. in diameter, on the central a little protruded lobe and pseudosuckers on the side lobes or flanks. The pseudosuckers extend a little behind the pharynx and are oval in shape measuring 0·08 mm. in length and 0·056 mm. in maximum breadth. The prepharynx following the oral sucker is very small and measures 0·01 mm. in length. The pharynx is round in shape, a little smaller than the oral sucker and measures 0·0396 mm. in diameter. The oesophagus is a narrow thin tube measuring 0·0726 mm. in length ; it bifurcates into very fine intestinal caeca which can be seen only upto the anterior limit of vitellaria due to the large number of vitelline follicles and crowding together of the genital organs. The ventral sucker, 0·0516 mm. in diameter, is nearly equal in size to the oral sucker and lies 0·42 mm. behind the anterior end of the body in the median line. The round holdfast organ with a narrow

median slit is situated 0·165 mm. behind the posterior margin of the ventral sucker and measures 0·1914 mm. in diameter, *i.e.* about one-sixth of the body length.

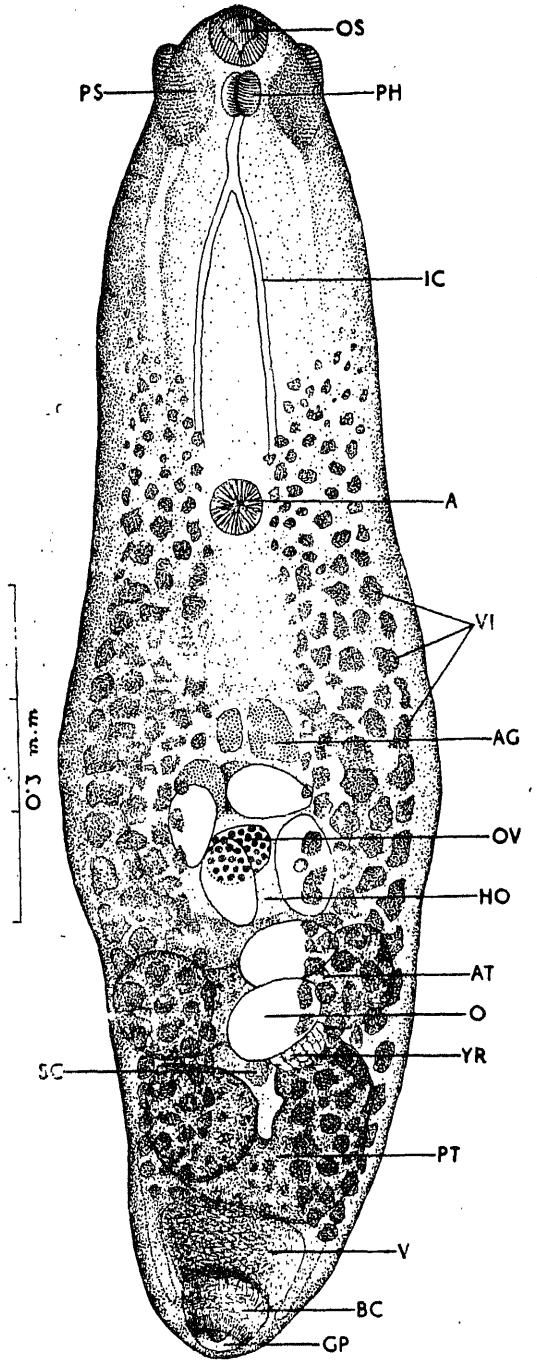
The testes situated behind the holdfast organ are tandem and lie very close to each other, occupying nearly the entire width of the body. They are symmetrical and horse-shoe shaped with a median concavity. The anterior testis, situated 0·043 mm. behind the holdfast organ, measures 0·096 × 0·245 mm. in size and the posterior testis, lying 0·1221 mm. in front of the posterior extremity of the body, is separated by a very narrow space from the anterior testis and measures 0·1716 × 0·245 mm. in size. The large sac shaped vesicula seminalis occupies nearly the entire intercaecal space behind the posterior testis. It joins the uterus through a narrow terminal duct to form the ductus hermaphroditicus.

The ovary situated on the median line dorsal to the holdfast organ, lies 0·06 mm. in front of anterior testis. It is somewhat transversely elongated, oval in shape and measures 0·05 mm. in length and 0·066 mm. in breadth. The shell gland mass forming the ootype lies in the space between the two testes in the middle. The uterus at first runs forward upto a little distance in front of the middle of the holdfast organ where it turns back forming a loop and finally forms a straight median tube which opens into the genital cone after meeting the male duct. The genital cone is quite large and fills up nearly the whole of bursa copulatrix which is not very big in size. The genital atrium nearly covers half of the posterior portion of the vesicula seminalis dorsally and is not separated from the rest of the body by a constriction. Genital opening is dorsal and nearly terminal.

The vitellaria consist of a large number of irregularly shaped follicles which mostly lie behind the ventral sucker and surround the holdfast organ but their number gradually decreases in front and they extend anteriorly only 0·116 mm. in front of the ventral sucker. In the region of the holdfast organ and behind it they run in two lateral bands upto the commencement of the vesicula seminalis where they terminate. The vitellaria do not unite posteriorly to form a common band in the testicular region. The uterus contains about 6–8 large sized ova measuring 0·083–0·091 mm. in length and 0·052–0·0627 mm. in maximum breadth. The yolk reservoir lies dorsally on the right side in the inter-testicular space slightly overlapping the posterior testis and the shell gland mass.

DISCUSSION

Glossodiplostomum duboisilla n. sp., resembles the type species *Glossodiplostomum glossoides* in many characters, such as the body being not divided into fore and hind parts, ratio between the size of the holdfast organ and the body length and general disposition of the genitalia. But the new species differs from the older one in the body size which is smaller and in having rounded oral and ventral suckers more or less of equal size (in the type species they are oval and ventral sucker is slightly bigger than the oral sucker). The pharnyx in the new species is rounded and oesophagus is longer than in *glossoides*. The disposition of vitellaria is also different in the two species, in *glossoides* after running laterally in the region of the holdfast organ they unite in the testicular region to form a median band which again divides into two behind the testes but in *duboisilla* vitellaria run throughout in the posterior region as two separate bands. The holdfast organ is rounded and much smaller in size in the new species than in *glossoides* where it is oblong in shape. The size of the ova is smaller in the new species and genital pore terminal and not subterminal.



Dorsal view of *Glossodiplostomum duboisilla* n. sp.

KEY TO LETTERING USBD IN FIGURE

A, acetabulum ; AG, adhesive gland ; AT, anterior testis ; BC, bursa copulatrix ; GP, genital pore ; HO, holdfast organ ; IC, intestinal caecum ; O, ovum ; OS, oral sucker ; OV, ovary ; PH, pharynx ; PT, posterior testis ; PS, pseudo-sucker ; SC, shell gland complex ; VI, vitellaria ; VS, vesicula seminalis ; YR, yolk reservoir.

Host : *Anhinga melanogaster* Pennant, 1769.

Habitat : Intestine.

Locality : Allahabad, India.

The author is very much indebted to Professor H. R. Mehra for valuable help and guidance in this work.

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STUDIES ON THE SYNERGISTIC ACTION OF PIPERONYL-BUTOXIDE AND SULPHOXIDE WITH PYRETHRUM—II

By

S. C. SAXENA

Department of Zoology, University of Gorakhpur

[Received on 6th October, 1960]

It has been reported by several toxicologists that certain compounds when added to pyrethrum so increase the toxicity that the dose required for knockdown is much less than that required with pyrethrum alone. In the present work two such compounds, piperonyl-butoxide and sulphoxide, have been selected for a study of their synergistic action. Toxic effect of the pyrethrum alone and combined with one or both of the synergists was studied by taking thanatosis or death feigning as a response. The action of piperonyl-butoxide as a synergist with pyrethrum has been reported by several scientists (Chamberlain 1950, Hewlett 1951, Blackith 1953 etc.).

MATERIAL AND METHOD

An equal volume of absolute alcohol was added to commercial 20% pyrethrum extract and was left for several hours in order to precipitate the resinous substances. The solution was then filtered and the resin free 20% pyrethrum was diluted with solvent, (mixture of analar petroleum ether b.p. 100-120 and liquid paraffin mixed in the ratio of 4 : 1), which does not effect thanatosis, and a 5% stock solution was prepared. Stock solutions of 1% piperonyl-butoxide and sulph oxide were prepared by diluting the chemicals with the above mentioned solvent.

Nearly 10 days old *Calandra granaria* and *Calandra oryzae* L., reared in the laboratory on wheat grains at constant temperature of 25°C were used as test insects.

The general technique involved two major operations ; (*a*) application of insecticides (*b*) assessment of toxic effect.

(*a*) Application of insecticides : The following method (Blackith 1950) was employed for the application of insecticide : The insects to be treated, whilst confined within the metal rings, were allowed to crawl over a thin film of the insecticide, which was provided on a 7 cm. Whatman filter paper by impregnating it with 0·5 ml. solution. The inner walls of the rings were coated with paraffin to check the climbing of the insects and were further covered by 7 cm. filter papers.

(*b*) Assessment of toxic effect : The duration of thanatosis of the insects which was recorded after an incubation period of 24 hours allowed to the treated insects, individually, with 2 wheat grains, was taken as the response. The method followed for recording the period of thanatosis was as previously described. (Saxena 1956).

DESIGN OF EXPERIMENT

7 experiments including 4 controls designed in the following manner were performed with *Calandra granaria* and *Calandra oryzae*. The chemicals were mixed

in equal proportions and 60 insects divided into 3 equal batches were taken for each experiment.

Experiment no. 1. Response to pyrethrum + pip. but.

Experiment no. 2. Response to pyrethrum + sulphoxide.

Experiment no. 3. Response to pyrethrum + pip. but. + sulphoxide.

CONTROLS

Experiment no. 4. Response to piperonyl-butoxide.

Experiment no. 5. Response to sulphoxide.

Experiment no. 6. Response to pip. but. + sulphoxide.

Experiment no. 7. Response to pyrethrum.

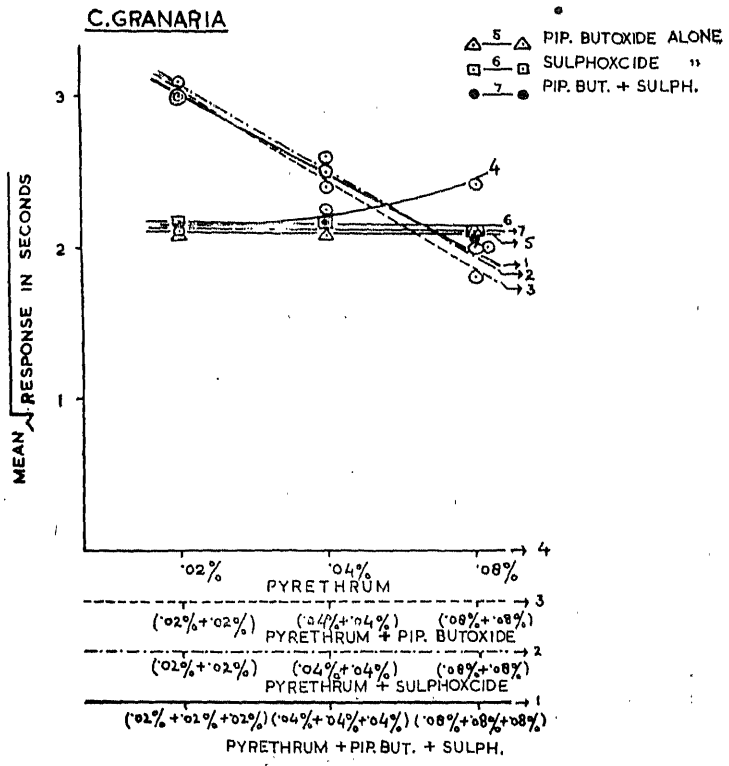

Fig. 1. Thanatosis response of insects to pyrethrum, piperonyl-butoxide, sulphoxide, pip. but. + sul., pyreth. + pip. but, pyreth. + sul. and pyreth. + pip. but. + sul.

Insects in each experiment were treated with the concentrations noted against the experiment in the table 1. Treatment periods allowed were of 24 and 4 hours to *C. granaria* and *C. oryzae* respectively. The mean transformed durations of thanatosis were plotted as ordinates against the concentrations spaced logarithmically as abscissae, (Figs. 1 and 2).

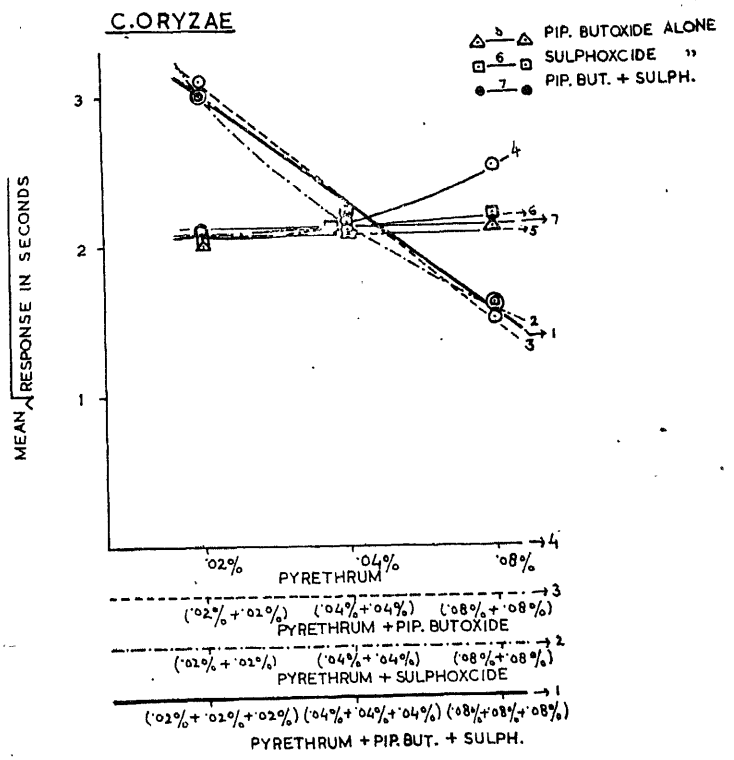

Fig. 2. Thanatosis response of insects to pyrethrum, piperonyl-butoxide, sulphoxide, pip. but. + sul., pyrethrum + pip. but., pyreth. + sul. and pyreth. + pip. but. + sul.

RESULTS

The following results given in table 2, were obtained :

Pyrethrum concentrations of ·02%, ·04% and ·08% selected for the treatment were probably metabolised by *C. granaria* as well as by *C. oryzae*, and no change in the period of thanatosis was noticed except in respect of that ·08% pyrethrum, which caused a slight increase in the period of thanatosis (Saxena, in press). The duration of thanatosis of the insects treated with ·02% ·04%, and ·08% piperonyl butoxide or with the same concentrations of sulphoxide were uneffected and no external symptoms were noticed.

·04%, ·08% and ·16% piperonyl-butoxide when mixed with the same concentrations of sulphoxide did not produce any change in thanatosis.

A considerable change in the period of thanatosis was noticed on subjecting the insects to the following mixtures :

1. (·04% pyreth. + ·04% pip. but.), (·08% pyreth. + ·08% pip. but.), (·16% pyreth. + ·16% pip. but.).
2. (·04% pyreth. + ·04% sulph.), (·08% pyreth. + ·08% sulph.), (·16% pyreth. + ·16% sulph.).

3. (·06% pyreth. + ·06% pip. but. + ·06% sulph.), (·12% pyreth. + ·12% pip. but. + ·12% sulph.), (·24% pyreth. + ·24% pip. but. + ·24% sulph.).

The changes in the periods of thanatosis of the insects treated with the above mixtures (1, 2 and 3), each of 3 different concentrations were identical whereas no change was recorded when the insects were exposed to these chemicals separately. The curves drawn for the different mixtures in the case of *C. granaria* and *C. oryzae*, when compared with pyrethrum curves of each (Saxena, in press), correspond to the stage when the duration of thanatosis begins to decrease (Figs. 1 and 2).

TABLE 1

Experimental Design with *C. granaria* and *C. oryzae*.

Experiment no.	Concentrations used	No of batches
1.	·04% pyrethrum + ·04% pip. but.	A
	·08% „ + ·08% „	B
	·16% „ + ·16% „	C
2.	·04% pyrethrum + ·04% sulphoxide	A
	·08% „ + ·08% „	B
	·16% „ + ·16% „	C
3.	·06% phreth. + ·06% pip. but. + ·06% sul.	A
	·12% „ + ·12% „ + ·12% „	B
	·24% „ + ·24% „ + ·24% „	C
4.	·02% piperonyl-butoxide	A
	·04% „ „	B
	·08% „ „	C
5.	·02% sulphoxide	A
	·04% „	B
	·08% „	C
6.	·04% pip. but. + ·04% sulphoxide	A
	·08% „ + ·08% „	B
	·16% „ + ·16% „	C
7.	·02% pyrethrum	A
	·04% „	B
	·08% „	C

TABLE 2

Thanatosis response of *C. granaria* and *C. oryzae* to pyrethrum, piperonyl-butoxide, and sulphoxide applied separately and jointly.

	Transformed mean durations of thanatosis in seconds on treating with		
Pyreth. conc.	·02%	·04%	·08%
C. granaria	2·11	2·25	2·4
C. oryzae	2·08	2·16	2·52
Pip. but. conc.	.02%	·04%	·08%
C. granaria	2·08	2·08	2·04
C. oryzae	2·01	2·09	2·12
Sul. conc.	·02%	·04%	·08%
C. granaria	2·17	2·15	2·08
C. oryzae	2·05	2·12	2·2
Pip. but. + sul. conc.	(·04% + ·04%)	(·08% + ·08%)	(·16% + ·16%)
C. granaria	2·16	2·16	2·04
C. oryzae	2·07	2·12	2·16
Pyreth. + pip. but. conc.	(·04% + ·04%)	(·08% + ·08%)	(·16% + ·16%)
C. granaria	3·1	2·4	1·8
C. oryzae	3·1	2·2	1·5
Pyreth. +sul. conc.	(·04% + ·04%)	(·08% + ·08%)	(·16% + ·16%)
C. granaria	3·0	2·6	2·0
C. oryzae	3·0	2·1	1·6
Pyreth. + pip. but.+ sul. conc.	(·06% + ·06% + ·06%)	(·12% + ·12% + ·12%)	(·24% + ·24% + ·24%)
C. granaria	3·0	2·5	2·0
C. oryzae	3·0	2·2	1·6

DISCUSSION

The experiments performed in this paper had the primary object of studying the action of synergised pyrethrum on the nervous system of insects. No change in the duration of thanatosis was recorded when the insects were treated with pyrethrum and synergists separately. The change in the period of thanatosis of the insects treated with synergised pyrethrum indicates the increased toxicity of

the mixed toxicant. This increase of potency of pyrethrum has been affected by the addition of synergists to the insecticide in the ratio of 1 : 1 by volume. Pyrethrum could be mixed with one synergist or with two synergists together. Whether the insects are treated with pyrethrum plus piperonyl-butoxide or plus sulphoxide or plus a mixture of piperonyl-butoxide and sulphoxide, identical changes in the duration of thanatosis are recorded, provided the same ratio is maintained in all the combinations. The experiments were designed to compare the effects of synergised pyrethrum by adding one or two synergists and the present investigation does not provide evidence on the cause of increase in toxicity of pyrethrum when synergists are added. By comparing the curves obtained by synergised pyrethrum and by pyrethrum alone (Saxena, in press), it appears that the action of synergised pyrethrum on the nervous system is similar to that of pyrethrum alone.

SUMMARY

The toxicity of pyrethrum is increased when piperonyl-butoxide and sulphoxide are added to it either separately or in a mixture, in equal proportion.

Identical response is recorded whether the insects are treated with pyrethrum plus piperonyl-butoxide or plus sulphoxide or plus a mixture of piperonyl-butoxide and sulphoxide.

It appears that the action of synergised pyrethrum and pyrethrum alone on the nervous system of the weevils is similar.

ACKNOWLEDGMENTS

The author wishes to express his sincere thanks to Dr. A. B. P. Page and Dr. R. E. Blackith for their constnt advice during the investigation.

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REPLACEMENT OF EPITHELIAL CELLS IN MIDGUT AND HEPATIC CAECA OF CERTAIN INSECTS.*

By

R. P. SRIVASTAVA

Zoology Department, Lucknow University

[Received on 3rd November, 1959]

INTRODUCTION

A number of structures such as discharged cytoplasmic globules, extruded nuclei, bursting cells etc. have been considered to be evidences of secretion discharge in midgut and hepatic caeca of insects by a large number of workers. Continuous replacement of worn-out cells and sudden degeneration and replacement of epithelium have been recorded by some workers. The majority of the workers, however, have still maintained the view that the discharged cytoplasmic globules, extruded nuclei etc. represent secretion discharges. The present investigations were, therefore, carried out on the conditions of epithelia in midgut and hepatic caeca of certain insects, under normal conditions, in order to see the exact position regarding the cell extrusions.

METHODS

Materials from three insects, *Leogryllus bimaculatus* Sauss., *Periplaneta american* Linn. and *Gryllodes sigillatus* Walk. were utilised for these studies. Specimens oa these insects were dissected soon after collection, anterior portions of their midgutf and their hepatic caeca were fixed by Yao-Nan and Mann-Kopsch techniques and 5 μ thick sections were obtained for the study.

OBSERVATIONS

The epithelium in both midgut and hepatic caeca consists of single layer of columnar epithelial cells. The columnar cells may be all of the same size (Fig. 1) or they may be distinguishable as longer older cells and shorter younger cells (Fig. 2). At times the distinction between the shorter and elongated cells may be much pronounced and formation of definite villi may occur (Fig. 3). Between the bases of groups of the columnar cells are spaces, in which are present groups of small oval cells, the regenerative cells, the groups being called nidi. At places where it is possible to distinguish between elongated and shorter cells, these nidi are seen to be surrounded by the shorter cells. The number and size of these regenerative cells in different nidi are quite variable. They may be compactly placed or they may be scattered. Examination of a large number of slides, exhibiting various conditions of the epithelia, suggests the following succession of events. The regenerative cells produce new cells. The new cells increase in size and increase in the number of cells in the epithelium may occur. As the newly formed cells grow, the epithelial cells just surrounding these shift to sides pressing the older cells there, which gradually become elongated. The nucleus in the latter cells may have to shift to the apical region because of the thinning out of the basal regions. Due to the elongation of the older cells, there appears a distinction between the short and elongated columnar cells and the surface of the

*Part of the thesis approved for Ph.D. degree of Lucknow University.

epithelium consequently may be alternately raised and lowered. As more cells are formed, the older cells may elongate further and formation of definite villi may occur. The older worn-out cells go on degenerating. The apical regions may become bulged out. The pressure from sides, due to the formation and growth of the new cells, facilitates extrusion of old worn-out cells. To start with, small globular masses of protoplasm may be extruded, then larger globules may be given off, the cells may burst giving out nuclei and protoplasm or the entire cell may simply be squeezed out (Fig. 4). The position of these extruded cells is then occupied by comparatively younger cells which await a similar fate. The loss is continually being compensated for by formation of new cells from the regenerative cells. The extrusion of old worn-out cells and the formation of new cells by regenerative cells result in a continuous replacement of the epithelial cells. This is, however, a gradual process and the cell extrusions, when present, are generally few, too small in number to suggest any significance in the matter of secretion discharge and are always found on the top of older cells. In many instances the epithelium may be entirely devoid of cell extrusions. However, at times, there occurs, in some parts of the epithelium, a rapid degeneration and regeneration. A large number of cells may be observed being under the process of extrusion in this area and the number of extrusions may be large (Fig. 5). A part of the epithelium with cells all of equal size (Fig. 1) also indicates the occurrence of a more or less complete degeneration of the epithelium followed by its replacement by the activity of the regenerative cells.

DISCUSSIONS AND CONCLUSIONS

Continued degeneration and extrusion of epithelial cells and their replacement was described by Henson (1929 and 1931) in *Vanessa urticae*, Woodruff (1933) in *Melanoplus differentialis*, Gresson (1934) in *Periplaneta orientalis* L. and Day and Powning (1949) in *Blatella*. A sudden breakdown of the epithelium and its regeneration was observed by Haseman (1910) in *Psychoda alternata*, Gresson (1934) in *Periplaneta orientalis* L. and Pradhan (1939) in *Coccinella septempunctata*. The real nature of cell extrusions, observed in midgut and hepatic caeca of insects, has still remained much disputed as majority of the workers appear to have taken van-Gehuchten's (1890) conclusions for granted who stated that the globular protrusions found on the top of certain epithelial cells in *Ptychoptera contaminata* were secretory globules. Poyarkoff (1910) in *Galerucella* and Buchmann (1928) in *Pyrausta* described discharge of secretory globules. Gresson (1934) observed in case of *Periplaneta orientalis* L., the separation of cell tips, discharge of cytoplasmic globules and bursting of cells as evidences of the secretory activity. Similarly Hodge (1936), in case of *Melanoplus differentialis*, considered such structures as secretory discharges. Saksena (1951), working on the alimentary canal of *Aulacophora*, also considered such structures as evidences of the secretion discharge. Pradhan (1936) observed occurrence of such structures as discharged cytoplasmic globules and extruded cytoplasm but did not mention whether he considered them to be evidences of the secretory activity or not for the purpose of avoiding a controversy (as stated by him in his paper). On the other hand, some workers did not regard these discharges to be related to the secretory activity at all. Henson (1929, 1931) stated that the so called secretory vesicles really represented result of cellular degeneration. Woodruff (1933) working on *Melanoplus* and Day and Powning (1949) on *Blatella* considered such structures as extruded cells, discharged nuclei and cytoplasmic globules etc. to have no concern with the secretory activity. On reviewing the works of those workers who regarded these structures to be secretion discharges it appears that mere presence of these extrusions along the epithelial surface led them to believe that these extrusions represented secretion discharges. The present

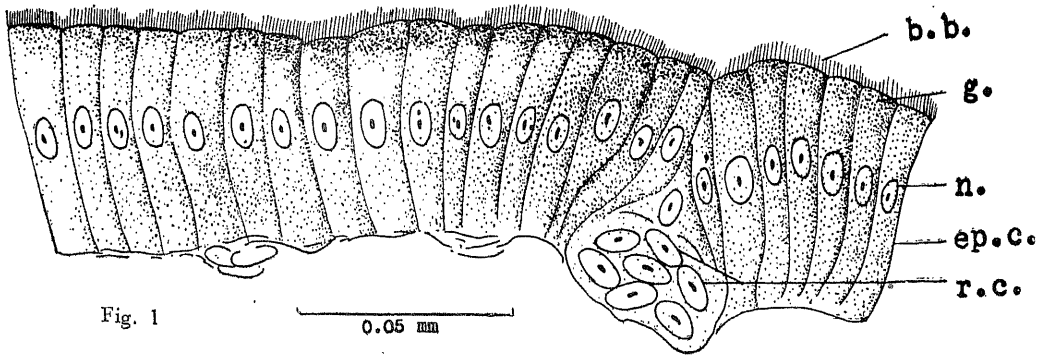

Fig. 1

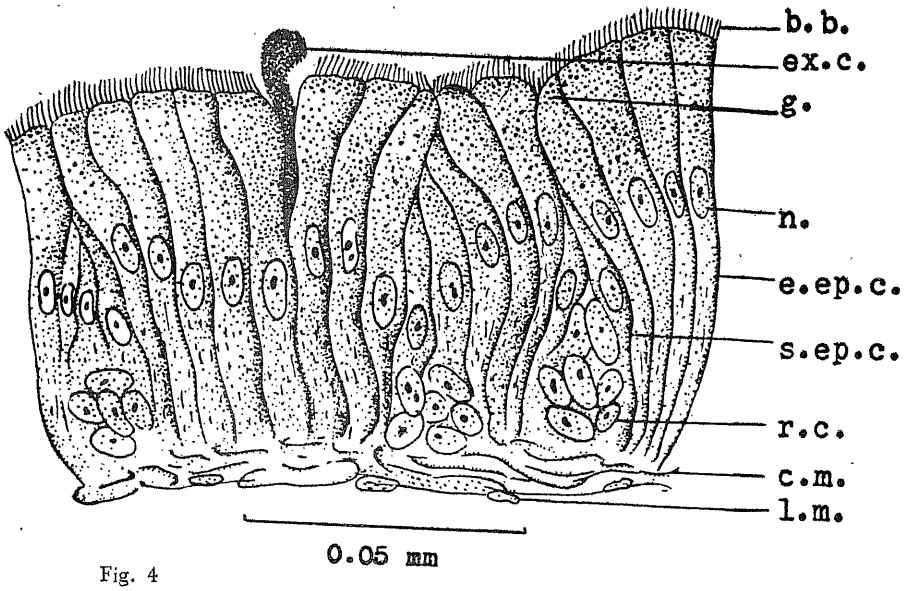

Fig. 4

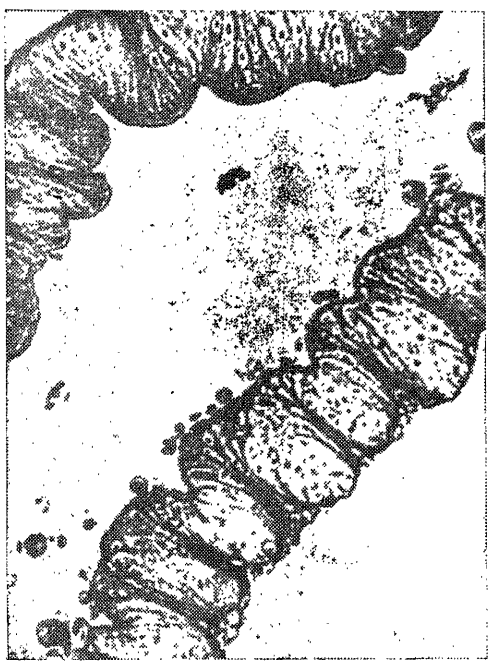

Fig. 5

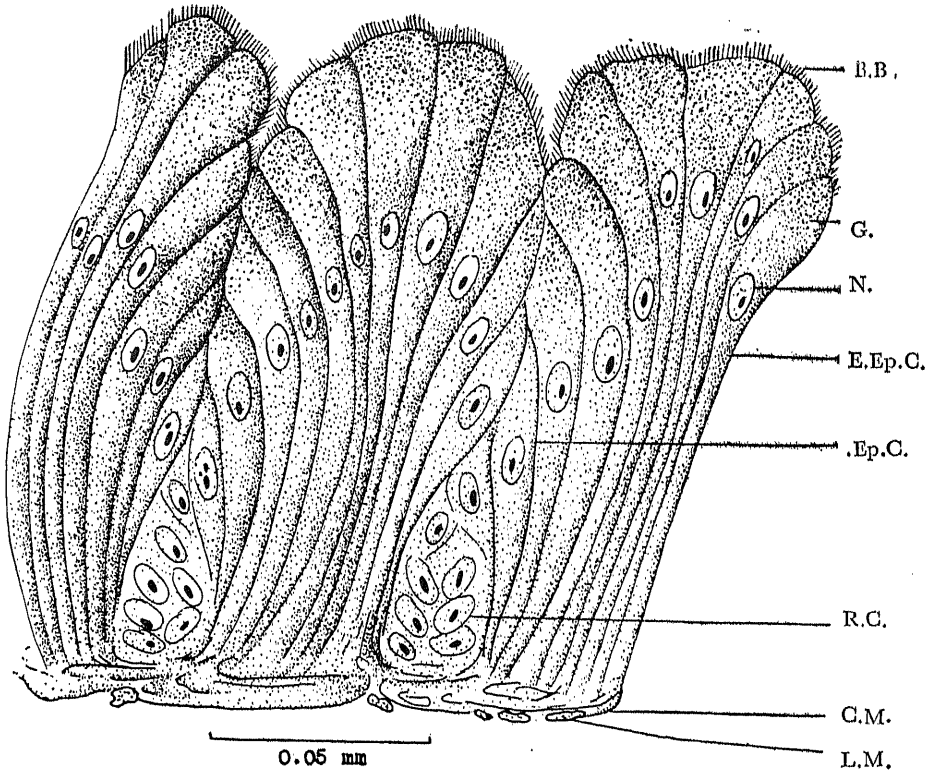

Fig. 2

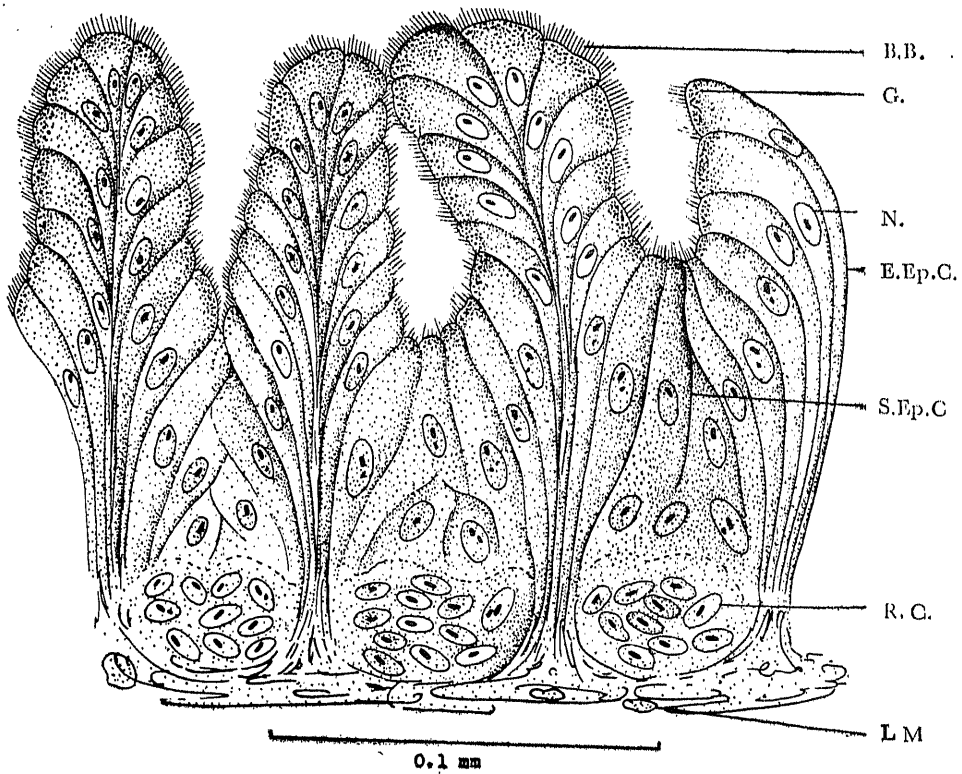

Fig. 3

studies show that there occurs a continuous replacement of the epithelial cells, the old worn-out cells getting degenerated and replaced by younger cells, as a result of which cell extrusions may be observed along the epithelial surface, representing cellular degeneration. The number of cell extrusions, however, is too small to suggest any significance in the matter of secretory activity. The facts that these cell extrusions always occur on top of old cells and may be entirely absent along certain epithelia, further support, that these represent cellular degeneration and not the secretory activity. The occasional occurrence of a large number of cell extrusions is due to the fact that, at times, there occurs a rapid degeneration of a part of epithelium and the number of the older cells under the process of degeneration being large, the cell extrusions also are numerous. The present author, therefore, concludes that there occurs a continuous replacement of epithelial cells and at times a rapid renewal of the epithelium in insects and the cell extrusions observed along the epithelial surface may be due to these processes, being results of cellular degeneration rather than the secretory discharges.

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EXPLANATION OF ILLUSTRATIONS

Fig. 1. Part of epithelium from hepatic caeca of *Gryllodes sigillatus* Walk. with cells all of equal size. Yao-Nan preparation.

Fig. 2. Part of epithelium from hepatic caeca of *Leogryllus bimaculatus* Sauss. with shorter and elongated cells. Yao-Nan preparation.

Fig. 3. Part of epithelium from midgut of *Leogryllus bimaculatus* Sauss. showing formation of villi. Yao-Nan preparation.

Fig. 4. Part of epithelium from hepatic caeca of *Leogryllus bimaculatus* Sauss. showing extrusion of worn-out cell. Yao-Nan preparation.

Fig. 5. Photomicrograph of a part of epithelium from hepatic caeca of *Leogryllus bimaculatus* Sauss. showing an area where rapid degeneration and extrusion of old worn-out cells is taking place. Mann-Kopsch preparation.

LETTERING

B.B., Brush border ; C.M., Circular muscles ; Ep.C., Epithelial cell ; E.Ep.C., Elongated epithelial cell ; Ex.C., Extruded cell ; G., Granules ; L.M., Longitudinal muscles ; N., Nucleus ; R.C., Regenerative cell ; S Ep.C., Short epithelial cell.

STUDIES ON GALL MIDGES (ITONIDIDAE : CECIDOMYIDAE : NEMATOCERA : DIPTERA) FROM INDIA—IV. TWO NEW SPECIES OF *TRISOPSIS* KIEFFER 1912

By

P GROVER

Zoology Department, University of Allahabad, Allahabad, India.

[Received on 14th August, 1961]

Subfamily *Itonididinae*

Tribe *Trifilini*

Trisopsis Kieffer

1912. *Trisopsis*, Kieffer, *Boll. Labor. Zool. Portics.*, **6** : 171.

1913. *Trisopsis*, Kieffer, *Gen. Ins.*, **152** : 136.

1925. *Trisopsis*, Felt, *Bull. N. Y. St. Mus.*, **252** : 171.

1929. *Trisopsis*, Felt, *Lingnan Sci. J.*, 7 : 475.

1945. *Trisopsis*, Mani, *Indian J. Ent.*, 7 (1 & 2) : 214 (1946).

1949. *Trisopsis*, Nayar, *Proc. R. ent. Soc. London*, **18** (5–6) : 87.

1955. *Trisopsis*, Rao, *Agra Univ. J. Res.* (Sci) **4** (1) : 254.

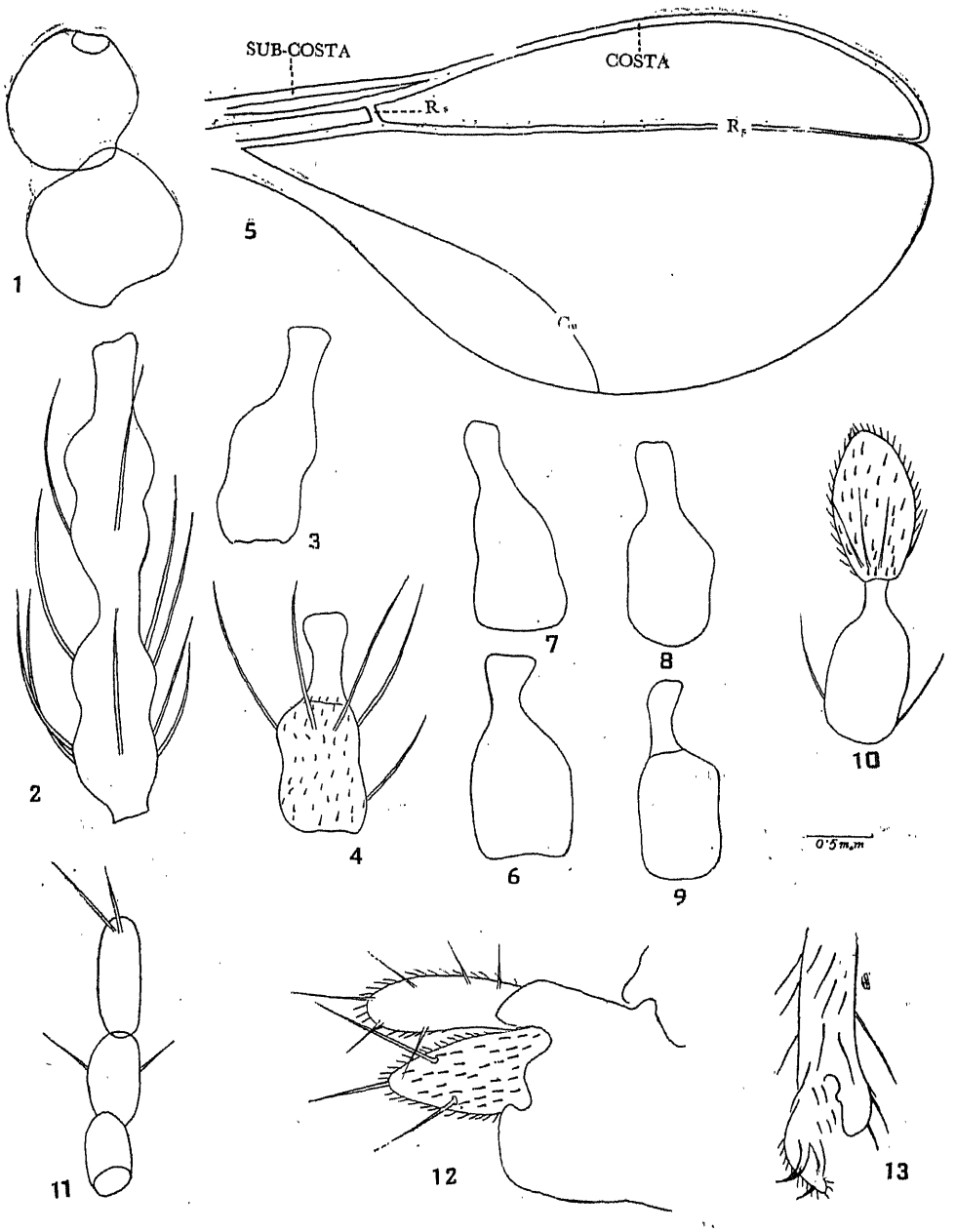
This genus is recognised by the following important characters : eyes three, dorsal reniform ; palpi triarticulate ; antenna with 14 segments, each segment having three whorls of nearly equal and regular circumfila and two whorls of long setae ; third and fourth antennal segments fused together ; wing with distinct vein R_5, vein R_5 joining wing margin at apex and interrupting the costa, vein *Cu* simple ; empodium as long as the simple and evenly curved claw ; terminal clasp segment long, curved and smooth, apex bifid, ovipositor with two sublinear lamellae.

Trisopsis oleae Kieffer

Up to now this genus was represented by a single species in the Oriental region. During the course of the present studies, two more species were collected and the same are described below as new species.

Trisopsis indicus sp. nov.

FEMALE.—*Body* length ·85 mm. long, pale brown to dark brown ; eyes not confluent above but separated into three parts, one dorsal and two lateral, the dorsal and one lateral parts of the eye are visible when mounted on a slide. *Antenna* pale-brown, shorter than the body, with 14 segments, enlargements constricted at the middle and with two whorls of long, stout and brown setae at the base and at apex, segments with prominent stems; scape (Fig. 1) pale-yellow, wider than long, sub-globose, pedicel (Fig. 1) pale-yellow, as long as scape, globose, sparsely setose ; third segment (Fig. 2) fused with the fourth segment and longer than the latter, with two whorls of long and stout setae, one whorl at the base and another at the apex, enlargement with a constriction in the middle showing



Text-figures 1–13 showing characteristic structures of *Trisopsis indicus*. 1. Scape and pedicel; 2. Third and fourth antennal segments ; 3. Fifth antennal segment ; 4. Sixth antennal segment ; 5. Wing ; 6. Seventh antennal segment ; 7. Eighth antennal segment ; 8. Ninth antennal segment ; 9. Tenth antennal segment ; 10. Penultimate and terminal segments ; 11. Palpus ; 12. Ovipositor ; 13. Claw.

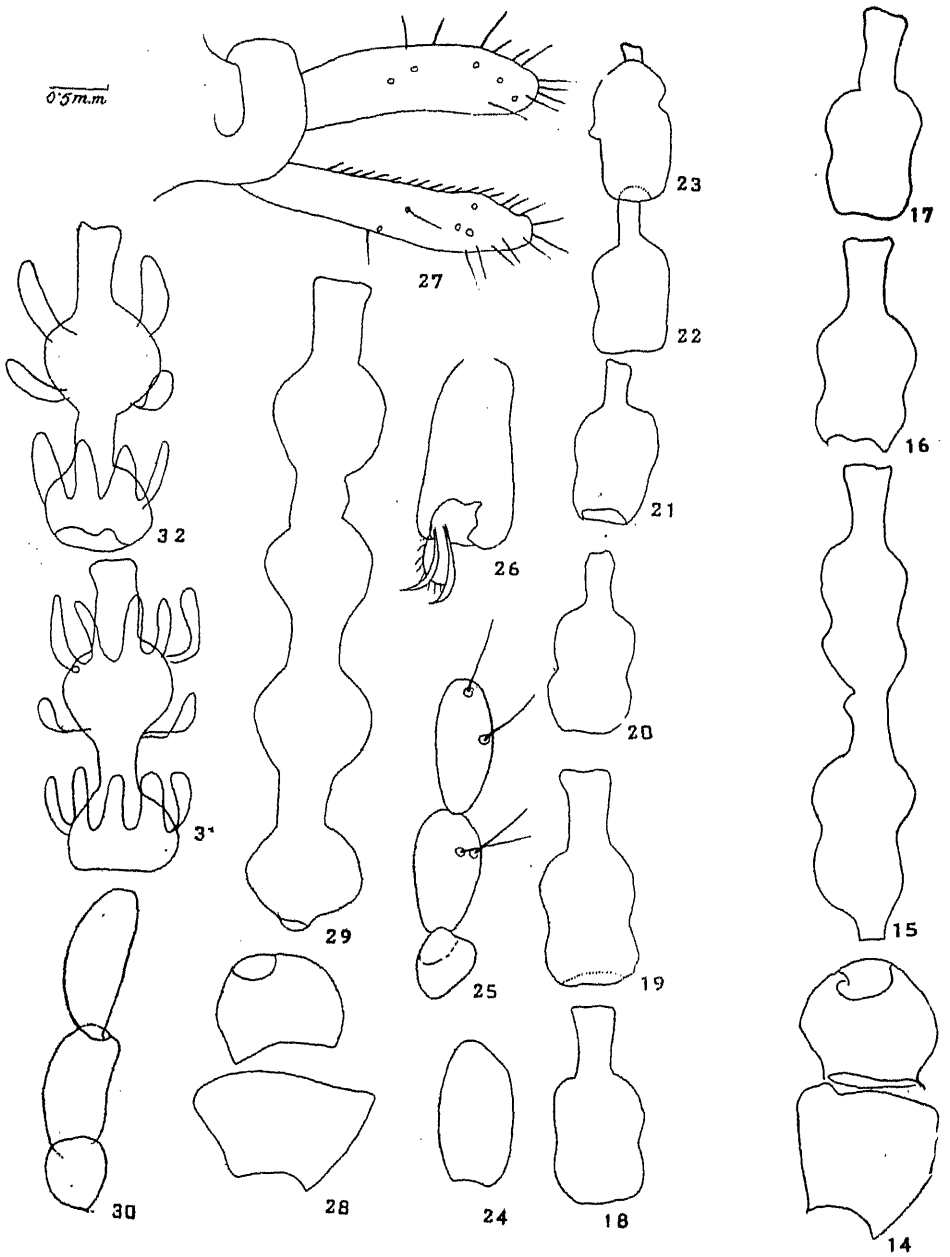
whorls of regular circumfila of nearly equal length, apical enlargement longer than the basal and subglobose; scape (Fig. 28) irregularly rectangular, palish brown wider than long ; pedicel (Fig. 28) shorter and narrower than the scape, subglobose, binodose in appearance, with short apical and basal stems, being nearly three-fifths the length of the segment and one-and-a-half its maximum thickness ; apical stem less than one-third the length of enlaregment and one-and-two-thirds as long as broad ; fourth segment (Fig. 2) a little shorter than the third, stem slightly shorter than half the length of enlargement and twice as long as broad ; fifth segment (Fig. 3) a little shorter than the fourth segment, enlargement two-thirds the length of the enlargement and twice as long as broad ; sixth segment (Fig. 4) as long as the fifth enlargement slightly shorter than two-thirds the length of the segment and slightly broader than long, stem more than half the length of the enlargement and three-and-a-half times as long as broad ; seventh segment (Fig. 6) of the left antenna, similar to the sixth but slightly shorter than the latter ; eighth segment (Fig. 7) a little shorter than the latter, enlargement similar to that of seventh segment, stem three-fifths the enlargement and thrice as long as broad ; ninth segment (Fig. 8) similar to the eighth ; tenth segment as in (Fig. 9) ; penultimate segment (Fig. 10) smaller than the preceding segment, enlargement five-sevenths the length of the segment and nearly one-and-a-half times as long as broad ; terminal segment (Fig. 10) shorter than the penultimate segment, conical without any constriction in the middle, length nearly one and-a-half times its maximum thickness, Palpi (Fig. 11) sparsely setose, light-yellow, triarticulate ; first segment subcylindrical, short, stout, length one-and-two-fifths of its maximum thickness ; second segment slightly longer than the first, cylindrical, length one-and-three-eigths the maximum thickness ; third segment longest of all, cylindrical, length two-and-a-half of its maximum thickness. Mesonotum yellowish brown, scutellum lighter than the latter ; abdomen palish-yellow. Wing (Fig. 5) hyaline, neither too long nor too broad, length two-and-a-half times its maximum breadth, vein R_s distinct, vein R_5 straight and reaching the wing margin beyond the apex, vein M_{1-2} absent, vein *Cu* simple ; halteres light yellow ; legs brownish-yellow, long, densely hairy, metatarsus as long as terminal tarsal segment, second tarsal segment longer than the rest of segments combined ; claw (Fig. 13) dark brown, simple, evenly curved, a little shorter than the empodium. Ovipositor (Fig. 12) light yellow, exserted, nearly one-eighth the length of the body, with oblong dorsal and triangular ventral lobes.

Holotype.—One female mounted on slide, labelled, "at light, P. Grover coll, King's Way, Nagpur, 27th April, 1960," is retained in the collection of author.

This species differs from *T. travancoricus* Nayar in the following characters : antenna shorter than the body, third antennal segment slightly longer than the fourth ; wing neither long nor too broad, vein R_5 reaching the costa beyond the apex of wing ; empodium longer than the claw ; ovipositor with dorsal oblong and ventral triangular lobes.

Trisopsis deepica sp. nov.

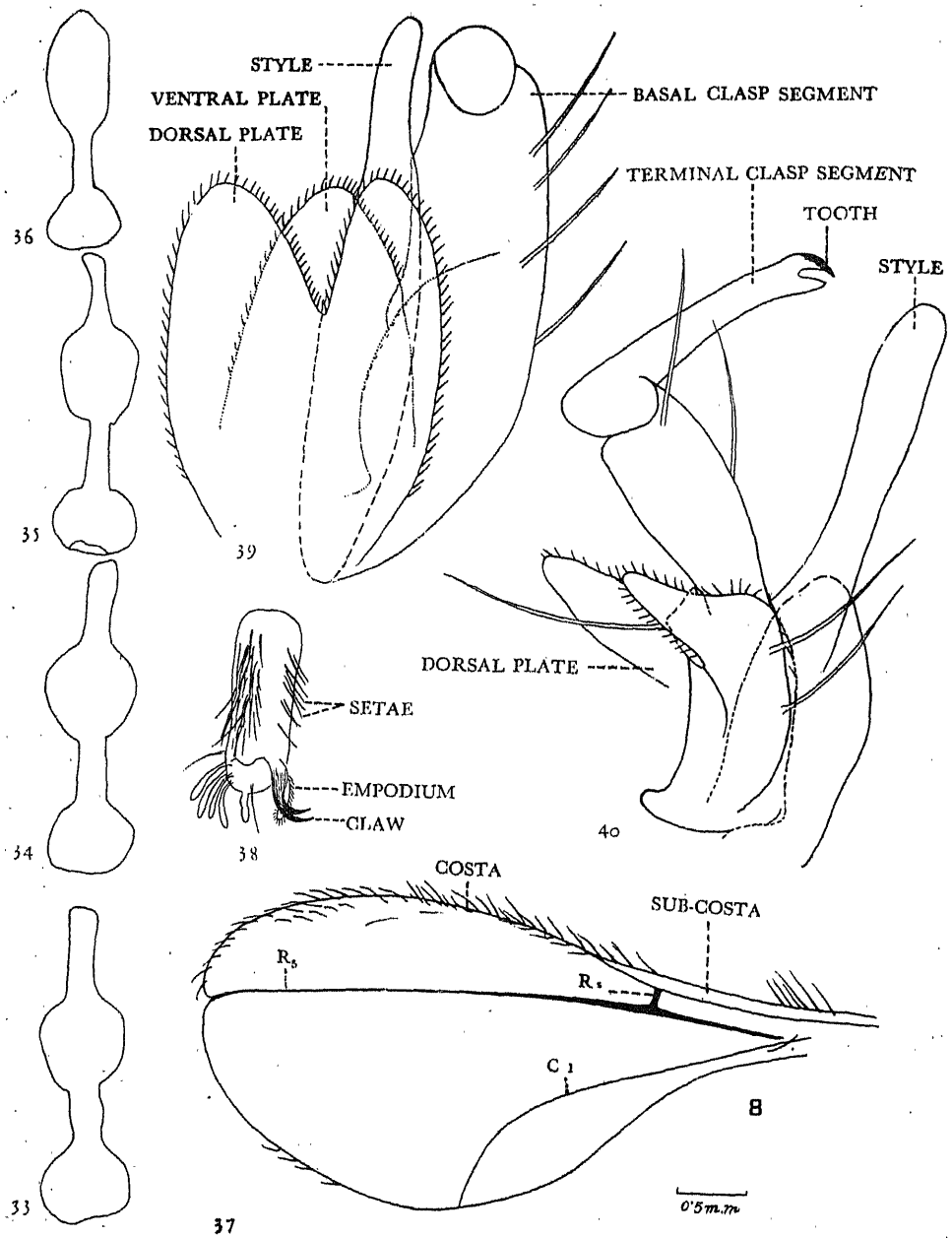
MALE.—*Body* 0·64 mm. long, yellowish-brown ; eyes not confluent above but three, typical of the genus, the dorsal eye group reniform. *Palpi* (Fig. 30) triarticulate, sparsely setose, palish-brown, first segment short, nearly globose ; second segment nearly twice the length of the first and one-and-three-fifths of its own thickness, subcylindrical ; third segment as long as second segment and slightly narrower than the latter, wider at middle. *Antenna* light brown, slightly shorter than the body, with 14 segments, binodose, enlargements with one whorl of long,



Text-figures 14–32. Diagnostic features of *T. deepica*. 14. Scape and pedicel of female ; 15. Third and fourth antennal segments of female ; 16. Fifth antennal segment of female ; 17. Sixth antennal segment of female ; 18. Seventh antennal segment of female ; 19. Eighth antennal segment of female ; 20. Tenth antennal segment of female ; 21. Eleventh antennal segment of female ; 22. Twelfth antennal segment of female ; 23. Penultimate segment of female ; 24. Terminal segment of female ; 25. Palpus of female ; 26. Claw of female ; 27. Ovipositor ; 28. Scape and pedicel of male ; 29. Third and fourth antennal segment of male ; 30. Palpus of male ; 31. Fifth antennal segment of male ; 32. Seventh antennal segment of male.

strong, brown setae at the base, basal enlargement with one and apical with two whorls of regular circumfila of nearly equal length, apical enlargement longer than the basal and subglobose ; scape (Fig. 28) irregularly rectangular, palish brown, wider than long; pedicel (Fig. 28) shorter and narrower than the scape, subglobose, slightly wider than long ; third segment (Fig. 29) fused with fourth and slightly shorter than the latter and longer than the scape and pedicel combined, basal enlargement with very short basal prolonation and longer than the apical enlargement nearly globose, basal stem less then half the length of basal enlargement and as long as broad, apical enlargement subglobose, slightly wider than long, apical stem similar to the basal ; fourth segment (Fig. 29) slightly longer than the third, basal enlargement nearly one-third the length of the segment and slightly wider than long basal stem one-half the length of the enlargement and as long as broad, apical enlargement similar to basal, apical stem longer than the basal and three-fourths the length of the enlargement and twice as long as broad ; fifth segment (Fig. 31) shorter than the third segment, basal enlargement one-fourth the length of the segment and two-thirds as long as broad, basal stem one-sixths the length of the segment, two-thirds the length of the basal enlargement and one-and.one-thirds times as long as broad, apical enlargement longer than the basal, two-thirds the length of the segment and subglobose, apical stem similar to that of fourth segment ; seventh segment (Fig. 32) as long as fifth, enlargement slightly narrower than that of the latter segment ; tenth-segment (Fig. 33) similar to the seventh except the apical stem, slightly narrower than that of the seventh segment and thrice as long as broad ; twelfth segment (Fig. 34) slightly shorter than the tenth segment, basal enlargement less than one-fifths the length of the segment five-seventh as long as broad ; basal stem as long as the basal enlargement and two-and-a-half times as long as broad, apical stem longer than the basal and three times as long as broad ; penultimate segment (Fig. 35) as long as the tenth segment, similar to the twelfth segment except the apical enlargement, slightly longer than wide, terminal segment (Fig. 36) shortest of all, basal enlargement less than one-fourth the length of the segment and slightly wider than long, basal stem similar to that of the penultimate segment, apical enlargement nearly twice the length of the basal enlargement and two times as long as broad, conical apically, without any apical prolongation. *Mesonotum* brown ; scutellum yellowish-brown ; wing (Fig. 37) hyaline, neither too long nor too broad, two-and-one-fourth times as long as broad, vein R_s distinct, vein R_5 reaching the costa at the apex of the wing and the latter is interrupted by its union, vein *Cu* simple. *Legs* yellowish-brown, long densely hairy, slender, metatarsus longer than the terminal tarsal segment, less than one-fourth the length of the second tarsal segment, third tarsal segment twice the length of the metatarsus and less than one-third the length of the second tarsal segment, terminal tarsal segment one-fourth the length of the second segment ; claw (Fig. 38) simple, evenly curved, black, empodium as long as the claw. *Genitalia* (Fig. 39 and 40) yellowish-brown, moderately setose ; basal clasp segment cylindrical, with basal lobe, thrice as long as broad, terminal clasp segment slender, broad basally, shorter than the basal clasp segment and longer than the dorsal and ventral plates, length over seven times the maximum thickness at middle, slightly curved, apex bifid, style as long as the basal clasp segment, nearly six times as long as broad. dorsal and ventral plates equal in length, dorsal plate broader than the ventral plate and as long as broad, deeply and narrowly incised in the middle, lobes rounded and beset with setae, ventral plate simple and nearly triangular, broad basally, tip rounded, twice as long as broad at one-fourth from the apex.

Holotype.—One male dissected and mounted on slide labelled, "at light, P Grover coll, dated 7th April, 1961 Allahabad."



Text-figures 33—40. Diagnostic features of *T. deepica*. 33. Tenth antennal segment of male ; 34. Twelfth antennal segment of male ; 35. Penultimate segment of male ; 36. Terminal segment of male ; 37. Wing of male ; 38. Claw of male ; 39. Genitalia (dorsal view) ; 40. Genitalia (side view).

Paratype.—One male dissected and mounted on slide and labelled as holotype some others in spirit retained in the collection of the author.

FEMALE.–*Body* 0·84 mm. long, eye three typical of the genus. *Palpi* (Fig. 25) palish-brown, sparsely setose, first segment shortest of all, nearly triangular length one-and-one-half times the maximum thickness at the apex, second segment sub-cylindrical, broad apically, less than twice the length of the first segment and twice as long as broad, third segment similar to the second but slightly narrower. *Antenna* with 14 segments, brownish yellow, segments constricted in the middle, enlargements with two whorls of long, stout setae, one whorl at the apex and another at the base ; scape (Fig. 14) palish-brown, as long as broad at the apex, cup-shaped ; pedicel (Fig. 14) shorter than the scape, slightly wider than long ; third segment (Fig. 15) fused with the fourth and slightly longer than the latter, enlargement constricted in the middle and with a very short basal prolongation, two-third the length of the segment and twice as long as broad, stem a little less than one-half the length of the enlargement and twice as long as broad ; fourth segment (Fig. 15) enlargement two-third the length of the segment and less than twice as long as broad, stem half the length of the enlargement and twice as long as broad ; fifth segment (Fig. 16) similar to the fourth segment ; sixth segment (Fig. 17) shorter than the fifth, enlargement three-fifths the length of the segment, one-and-one-eighths as long as thick, stem two-third the length of the enlargement and three times as long as thick ; seventh segment (Fig. 18) slightly longer and narrower than the sixth and nearly one-and-a-half times as long as thick ; eighth segment (Fig. 19) slightly longer than the seventh, enlargement longer than that of the seventh segment, stem three times as long as thick ; tenth segment (Fig. 20) as long as the sixth segment, enlargement similar to that of the eighth segment, stem short, nearly one-third the length of the enlargement and twice as long as thick ; eleventh segment as in (Fig. 21) ; twelfth segment (Fig 22) shorter than the tenth segment, enlargement nearly three-fourths the length of segment and one-and-one-half times as long as thick, stem similar to that of the eleventh segment; penultimate segment (Fig. 23) shorter than the twelfth segment and as long as terminal segment, enlargement slightly less than twice the maximum thickness, stem nearly one-sixth the length of the enlargement and as long as thick ; terminal segment (Fig. 24) conical, without any constriction, twice as long as thick. *Mesonotum* dark brown to palish-brown, scutellum and post-scutellum light brown ; abdomen yellowish brown, sparsely setose ; halteres and wing as in the male ; legs slender, densely hairy, metatarsus longer than the terminal tarsal segment and shorter than the second tarsal segment, fourth tarsal segment equal to the fifth tarsal segment, metatarsus nearly one-third the length of the second segment, third tarsal segment a little less than half the length of the second tarsal segment ; claw (Fig. 26) simple, dark brown, evenly curved, empodium shorter than the claw ; ovipositor (Fig. 27) light yellow, sparsely setose, exserted, with one dorsal elongated oval and two ventral oblong lobes.

**Allotype.*—One female dissected and mounted on slide labelled as holotype in the collection of the author.

These species differ from the *T. travancoricus* Nayar and others in the following points ; comparatively small size of the body ; antennae being shorter than the body, the shape and the proportion of the antennal segments, second and third palpal segments being equal ; third and fourth antennal segments unequal, ventral plate of the male genitalia being as long as dorsal plate, style as long as basal clasp

*As these midges were collected "at light" from the same place, at the same time and day, one after the other under the similar conditions they may be paratypes and allotypes of the described holotype.

segment, dorsal plate deeply and narrowly incised in the middle, empodium in the female shorter than the claw ; ovipesitor with one dorsal elongated oval and two ventral oblong terminal lobes.

KEY TO SPECIES

1. Antenna longer than the body, third and fourth antennal segments equal, wing long and narrow, empodium as long as claw in male and shorter in female, ovipositor lobes broadly oval.....*T. travancoricus* Nayar
   Antenna shorter than the body, second and third palpal segments equal or unequal, wing neither too long nor too broad.....2
2. Second and third palpal segments equal, empodium equal to claw ; ovipositor with dorsal elongated oval and ventral oblong terminal lobes, dorsal plate deeply and narrowly incised in the middle, ventral plate with rounded tip basal clasp segment with basal lobes, style as long as basal clasp segment.....*T. deepica* sp. nov.
   Second and third palpal segments unequal ; third antennal segment longer than the fourth, empodium longer than the claw, ovipositor with long dorsal lobe and triangular terminal ventral lobes.....*T. indicus* sp. nov.

ACKNOWLEDGMENTS

I am greatly indebted to Prof. M. D. L. Srivastava of the Zoology Department, Allahabad University for all the facilities provided. The author expresses her deep gratitude to Dr. S. N. Prasad for supervision and guidance. She is also grateful to Dr. S. N. Rao for encouragement and help.

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A NOTE ON BREAKING CLIMATIC DIAPAUSE OF THE LARVAE OF *BIMBA TOOMBII* GROVER[1]

By

S. N. PRASAD *and* P. GROVER

Department of Zoology, University of Allahabad

(Received on 6th March, 1962)

During the course of the study of the Biology of the gall-midge *Bimba toombii* Grover it was discovered that the fourth instar larva was the over-wintering stage.[2] To elucidate this point further, some fourth instar larvae were kept under observation in early November 1961, as the winter began advancing. These were observed regularly and were found living normally even through the unusually cold winter in this year.[3]

On January 24th 1962 (Temp. Max. 20°C, min. 5°C) twelve larvae out of this lot were transferred to a constant temperature room at 30°C to see the effect of temperature on the over-wintering larvae. Daily observations continued upto the 14th February, but no changes were found in the larvae. They, however, looked healthier and relatively more active, the reason being that they were kept more carefully now than in the past when they were kept in the dust exposed shelf of a working table in the laboratory. From the above, it is evident that the temperature change alone did not produce any effect on the larvae materially and they continued to be at the same immature stage at which they were placed.

Attempt was then made to increase the humidity around the larvae in order to revive their normal developmental activity. In the absence of a humidifier, 40% KOH was kept at the base of a desiccator and the cavity block, containing the larvae, was transferred to the desiccator. 40% KOH gave an increased humidity at 55% as observed with the help of a Dry and Wet bulb thermometer, while the humidity in the atmosphere was 37%.

The observations made on the next morning revealed that the larvae were more active and lively. The larvae were transferred to the desiccator, having increased humidity within, on the 15th February 1962 and from the 16th February, 1962 the imaginal buds of the head and thoracic regions started showing signs of growth with the result that six days later *i.e.* on 21st February, 1962 one of the larvae showed definite signs of pupation and on the 22nd February a normal exarate pupa was formed. Under normal conditions a freshly formed fourth instar larva takes almost the same time (6–8 days) to pupate.[2]

This pupa was observed twice daily and it kept on growing just as normal pupae do. On the 24th February two more larvae pupated, 3 each on the 26th and 27th February. All the pupae kept growing normally. First the pupae became brown, appendages developed, mouth-parts differentiated, wing pads grew more and more prominent changing into wings, and finally the eyes became dark, even rows of setae, on the abdominal terga, became distinct. Just before emergence

1. The work is in progress.
2. P. Grover : Biology of *Bimba toombii* Grover (in press).
3. The winter (1961–62) was unusually cold so much so that the temperature remained at the freezing point for several days.

the pupa started active body movements—expansions and contractions of the body. A normal male fly emerged from the first pupa, sometimes in the night of 27/28 February. The time taken by the pupal instar was six days, which comes in the time range for the emergence of normal pupae. The fate of the other pupae has been summarized in the Table A.

TABLE A

No. of larvae kept	Date	No. of larvae pupated	Date of pupation	Date of Emergence	Duration of pupal instar
12*	24th Jan.	1	22nd Feb.	28th Feb.	6
*One larva killed during handling		2	24th ,,	1st March	5
		3	26th ,,	5th ,,	7
		3	27th ,,	7th ,,	8
		2	28th ,,	5th ,,	5

On the 24th February, another batch of 10 larvae (B), taken out from the old galls, was kept. This time, however, the strength of the KOH solution was raised to 60% in the desiccator, which succeeded in creating 65% of humidity. The atmospheric humidity on the day was 32%. These larvae behaved, perhaps, in the most orderly fashion. All of them pupated in 5 days time and emergence also took place in the normal way (Table B).

TABLE B

No. of larvae kept	Date	No. of larvae pupated	Date of pupation	Date of Emergence	Duration of pupal instar
10	24th Feb.	3	28th Feb.	5th March	5
		2	1st March	5th ,,	4
		3	2nd ,,	8th ,,	6
		2	3rd ,,	8th ,,	5

A third batch of larvae was kept on the 27th February, 1962. This time the strength of KOH was raised to saturation in one desiccator and the other contained 60% solution of KOH. The larvae placed in 65% humidity again behaved better and pupated within six days, but the observations could not be continued further due to certain difficulties.

* P. Grover, "Biology of *Bimba toombii*" (in press).

TABLE C

No. of larvae kept	Date	No. of larvae pupated	Date of pupation	Date of Emergence	Duration of pupal instar
12	27th Feb.	4	4th March	8th March	4
		2	5th „	9th „	4
		2	6th „	..	..

Those kept in the desiccator containing saturated solution showed two extremes. Some mature larvae pupated overnight but a number of larvae died on the second day and the rest on the third day. Because of the high death roll of the larvae the pupae were transferred to the desiccator containing 60% KOH. There they behaved normally before the work had to be discontinued.

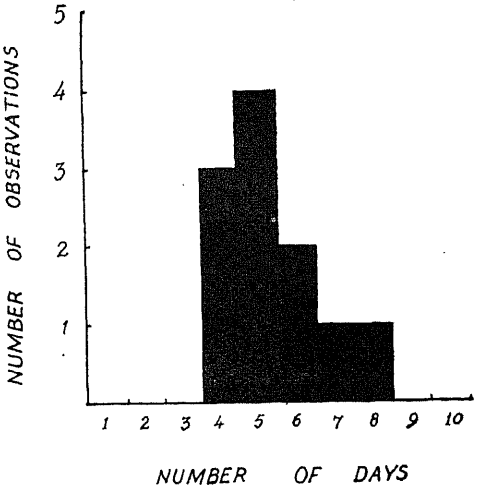

Fig. 1. Histogram showing the time taken by the pupal instar. The emergence in this case took place as in the normal pupae.

On the 9th March 1962, all the desiccators were transferred to the laboratory where the temperature was 27°C, lower than that of the constant temperature room by 3°C. Observations were continued for a week in this condition and it was found that the larvae and pupae turned sickly and did not change further.

From the above it may be concluded that both the temperature and humidity control the diapause in these larvae. A rise of the temperature only had no effect, the larvae kept at constant temperature from 24th Jan. to 14th Feb. did not show any sign of pupation. Likewise, only rise in humidity did not effect the larvae and pupae, for, as soon as they were taken out of the constant temperature room they not only stopped growing but even emergence was delayed.

The larvae of *B. toombii* continue to develop uninterruptedly as long as normal conditions prevail and diapause occurs as soon as one or both of the important environmental factors (such as temperature, humidity etc.) fall below a certain

threshold of tolerance. The percentage of individuals entering diapause depends upon the age-distribution of the population and on the degree of unfavourableness of the factor or factors concerned. Return to the normal environmental conditions breaks the diapause. To avoid confusion a word may be added about hereditary diapause which over rules all ecological influences. In this case heredity plays an important part in the diapause, which sets in at a fixed stage of development idependent of all possible environmental conditions and is not broken even in favourable conditions until a certain period of time has passed. The case of *B. toombii* is of common climatic diapause and not the one in which heredity intervenes.

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CYTOLOGICAL STUDIES OF SOME SPHAEROPSIDALES—II
THE CHONDRIOME AND NUCLEI

By

R. K. SAKSENA *and* DINESH KUMAR

Botany Department, University of Allahabad, Allahabad

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INTRODUCTION

French cytologists gave the term chondriome to the entire mitochondrial contents of a cell or tissue. Newcomer (1948) preferred the term 'Mitochondria' (mitos—a thread, chondrion—small grain) previously coined by Benda in 1817, as it referred to those granules, rods or filaments in the cytoplasm of nearly all the cells which were preserved by bichromates in a pH range approximately between 4·6 and 5 and which were destroyed by acids or fat solvents. Later on, in 1951, he proposed the retention of this term because of priority, etymology, common usage and adequacy for the present knowledge of the subject. However, Guilliermond (1941) used the term mitochondria specifically to designate granular forms. Hackett (1955) in his recent review stated that, "The nomenclature of nonplastid cytoplasmic particulates of plant cells has a long and confused history." He used the term mitochondria in a generic sense. He refers this terminology to the collection of all forms of particles usually 0·5 to 1·0 μ in diameter and upto 10 μ or more in length. Hackett (1. c.) states that these particles are morphologically heterogenous (sphere, rods, threads) and are also fragile, capable of undergoing many changes in form when subjected to different experimental conditions and since the thread like forms break up into granules and rod shaped ones change to spheres a definite morphological classification of these types is extremely difficult. According to him, much importance cannot be attached to such differences in the present state of knowledge.

The study of the chondriome in recent years has come to occpuy an interesting position in Botany as some of the hitherto obscure cellular functions have been ascribed to these structures by several workers. The study of these particles has been made both in living and fixed conditions. They are visible in the microscope characterised by certain size, shapes and staining properties. Accordnig to Hackett (1955) these cytoplasmic inclusions are composed largely of lipids and proteins (in addition to water) and are generally stained with Janus Green Hoĕht B. The present workers in this field suggest that the result obtained from fixed, sectioned and stained preparations should be confirmed *in vivo* observations. The use of 2, 3, 5 triphyenyl tetrazolium chloride and its derivatives has also become very common in the study of cytoplasmic inclusions of plant cells.

The first detailed description of mitochondria in plant cells was made by Meves (1904) who observed them in the tapetum cells of young another of *Nymphaea alba,* fixed with Flemming's fluid and stained with haematoxylin. Gulliermond (1911) for the first time thoroughly described the chondriome in fungi in the ascus of *Pustularia vesiculesa* though Meyer had observed living chondrisomes in *Achlya* and described them as leucoplasts as early as 1904. Later on, mitochondria were reported from various groups of fungi ranging from the Plasmodiophoraceae to the Autobasidiomycetes.

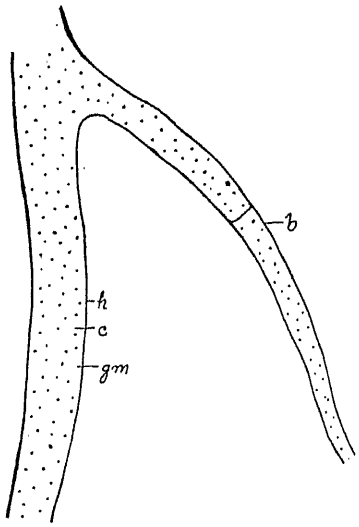

Fig. 1

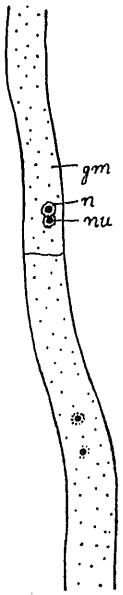

Fig. 2

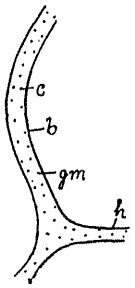

Fig. 3

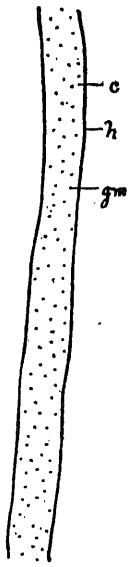

Fig. 4

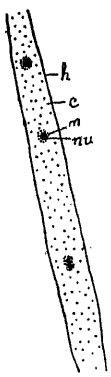

Fig. 5

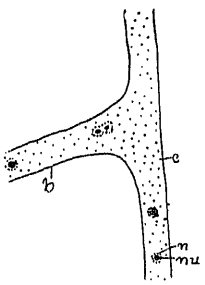

Fig. 6

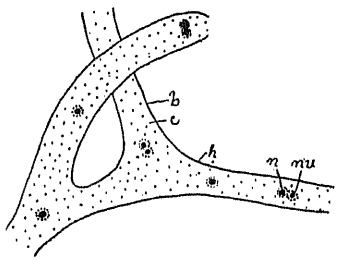

Fig. 7

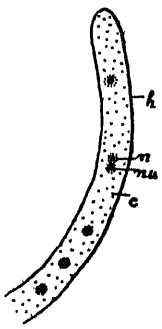

Fig. 8

Abbreviations
b = branch ; c = cytoplasm ; h = hypha ; gm. = granular mitochondria ;
n = nucleus ; nu = nucleolus.

Fig. 1–4 Portions of hyphae *Botryodiplodia* Γ2, *B. theobromae*, *Diplodia cajani* and *Macrophomina phaseoli* respectively fixed in sublime formol, showing granular mitochondria.

Fig. 5–8 Portions of hyphae of above fungi fixed in Raper's fixative, showing resting nuclei.

All the figures are magnified × 1500

The authors have not come across any literature dealing with an account of the chondriome in the members of the Sphaeropsidaceae. The present work was taken up with a view to make a study of the chondriome in the vegetative mycelium of some members of the family.

As in the case of mitochondria practically no attention has so far been paid towards the nuclear behaviour in the Sphaeropsidales. The nuclei of the organisms studied are extremely small and this fact made their study difficult.

MATERIALS AND METHODS

Four species of Sphaeropsidales, *viz.*, *Botryodiplodia* Sp., *B. theobromae* Pat., *Diplodia cajani* Raychaudhuri and *Macrophomina phaseoli* (Maubl) Ashby were taken for this investigation.

The vegetative mycelium was studied both in the living and fixed conditions. The material for study was obtained by growing the fungus for 36–48 hours on a medium containing 5·0 gms. glucose, 2·0 gms. asparagine, 0·5 gms. $MgSO_4$. $7H_2O$ and 0·5 gms. K_2HPO_4 dissolved in 1000 c.c. of distilled water. The cultures were maintained at 25°C.(± 1.)

Suitable material was fixed in various fixatives, *viz.*, Helly's liquid, Sublimé formol and liquid of Lenhossek for mitochondrial studies and Flemming's weak solution (modified by Saksena), Flemming's fluid (strong) and Raper's fixative for nuclear studies. The material was stained with 0·5% haematoxylin and gentian violet by the usual process. The preparations were mounted *en masse* in Canada balsam.

OBSERVATIONS

I. Living conditions :

The study of actively growing mycelium of the various fungi under high power of the microscope could not reveal anything due to the thinness of the hyphae. However, a study under oil immersion lens revealed minute fat particles moving about in the cytoplasm. Mitochondria could not be detected in unstained preparations even under oil immersion lens.

Supra vital Staining : The mitochondria could not be stained with Janus Green Höcht B. because of the granularity of the cytoplasm. When stained with 2, 3, 5 tetrazolium chloride (·005—·01% in distilled water) mitochondria in granular form took up red stain. These forms could be seen under oil immersion lens.

II. Fixed conditions

Of the various fixatives tried in the present experiment best results were obtained in sublime formol. Mitochondria were not observed in mycelia fixed in liquid of Lenhossek. Helley's liquid also did not give good results.

The mitochondria were stained black with haematoxylin. In all the cases only granular mitochondria were observed in the vegetative hyphae (Figs. 1–4).

Nuclei

No nuclear division could be observed in any of the organisms studied. In resting stage nuclei were seen best in the material fixed in Raper's fixative. Sublimé formol, which was used for the fixation of mitochondria, fixed nuclei also. In the resting stage a deeply stained central body (nucleolus) was seen enclosed within a membrane. No chromatin threads were visible (Figs. 5–8).

DISCUSSION

At first Dangeard (1919, 1920, 1921) thought that mitochondria belonged to the intitial forms of vacuolar system. He, however, gave up his idea after being

criticised by Guilliermond (1920, 1921 *a* and *b*) and recognised them as discrete elements and not corresponding to young vacuoles.

Recently Sorokin and Sorokin (1956) while employing 2, 3, 5 triphenyl tetrazolium chloride and its derivatives concluded that the tetrazolium salts were reduced to red formazone by the activity of some enzymes. They, therefore, preferred neotetrazolium chloride for their studies. Ritchie and Hazeltine (1953) observed that the reduction of 2, 3, 5 triphenyl tetrazolium chloride took place in small granules thought to be mitochondria in regions of hyphae of *Allmoyces*, just below the tip. During their study, they found this dye to be least toxic in lower dozes below ·01% concentration. Mitochondria observed by these authors were spherical in shape. The results of the present study confirm the above findings and also the observations made by Raizada (1957) who also noticed granular mitochondria stained red with 2, 3, 5 triphenyl tetrazolium chloride in some species of the Mucorales. According to Guilliermond (1941, p. 68) the mitochondria in Saprolegiinaceae got profoundly altered if treated with fixatives containing alcohol and acids but do not get entirely dissolved as reported earlier. Saksena (1936) found that in case of *Pythium* liquids of Bouine (containing acetic acid) and Lenhossek (containing both absolute alcohol and acetic acid) did not profoundly change the mitochondria. In the present study no mitochondria could be seen when fixed in the liquid of Lenhossek.

SUMMARY

1. During the study of the chondriome in the case of four species of the Sphaeropsidales, mitochondria in the form of granules were seen. These structures could be stained with 2, 3, 5 triphenyl tetrazolium chloride supravitally but not with Janus Green Hötch B.

2. Best preservation of mitochondria was obtained by fixing the material in sublimé-formol. Only granular forms were observed.

3. Nuclei in resting stage were seen in all the fungi studied.

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STUDIES ON THE VEGETATION OF ARID ZONE OF INDIA VIII. COMPOSITION OF SOME SCRUB COMMUNITIES OF CHURU—RAJASTHAN

By

B. M. SHARMA

Central Botanical Laboratory, Allahabad

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Puri, Sarup and their associates (1958, 1959, 1960 *a*, *b*, 1961, *b*, *c*) have published a series of papers dealing with various aspects of the Indian Arid Zone ecology. The present paper is in the same series and deals with the composition of some scrub communities of arid zone vegetation developed at Churu, Rajasthan. An attempt has also been made to present here a short review of salient literature on the Indian Arid Zone ecology, to show how far this subject has progressed since Blatter and Hallberg (1918–1921) published their first studies and what gaps are still to be filled in our knowledge.

It is only recently that the Rajasthan Desert has attracted the attention of Indian Botanists. The vegetation of the area has not been studied ecologically in detail, though floristic accounts are available from early times (Hooker and Thomson, 1855 ; Hooker, 1872-1897, 1904) ; King (1879) published a 'Sketch of the flora of Rajputana', being followed by a detailed work of Blatter and Hallberg (1918-1921) who described the vegetation of Jodhpur and Jaisalmer regions. It was only in the last decade that a number of workers took up studies on desert ecology dealing mainly with the vegetational aspect. Sarup (1951) published a list of plants of Jodhpur and its neighbourhood. Dass and Sarup (1951) studied the biological spectrum of the Indian Desert and compared it with African and Egyptian Deserts. In 1952, a symposium on the Rajasthan Desert was arranged by the National Institute of Sciences of India wherein a number of workers like Agharkar, Biswas, Puri, Sarup and others had contributed to the ecological aspects of the vegetation. Puri (1952) summarised the position of plant ecology of deserts of Rajasthan and Saurashtra upto 1951 ; Biswas (1952) and Biswas and Rao (1953) described the Rajputana Desert vegetation. Krishnaswamy and Gupta (1952) later worked on the vegetation and soils of the Rajputana Desert. Sarup and Vyas (1953) studied the plant ecology of Jodhpur Tehsil. Sarup and Datta (1954) presented a preliminary correlation of plant community with soil conditions. Sharma (1954, 1956, 1959, 1961 *a*, *d*.) has worked on weeds and studied stomatal frequency of the desert plants. He has also carried out the chemical analysis of desert plants and soils to give a correlation between vegetation and environment.

Vegetation of the eastern part of the desert has been studied by Mulay and Ratnam (1950), Ramchandran (1950), Ratnam (1951), Ratnam and Joshi (1952), Bakshi (1954), Bakshi and Kapil (1952, 1954), Nair (1954, 1956), Nair and Joshi (1955), Nair and Nathawat (1956, 1957) and Joshi (1956-1958). These authors have studied the vegetation around Pilani and other neighbouring areas. Joshi (1956) in his study of plant ecology of Bikaner has compared it with neighbouring areas of Rajasthan and showed that the present area resembles the arid divisions of Western Rajasthan like Jaisalmer and Phalodi and Sandy plains of Shekhawati

in the east. He has further shown the vegetation to be of the status of *Calligonum-Zizyphus-Capparis* association. The same author in his survey of the sand dune vegetation of Pilani has shown that the existing vegetation seems to be a *Prosopis-Capparis* climax association.

Autecological studies of the desert plants have also been carried out by a number of workers like Bakshi and Kapil (1954) on *Molluge nudicaulis* and *M. ceryiana.*, Sarup and Singh (1953) on *Tephrosia purpurea*, Sarup and Tandon (1954) on *Gynandropsis pentaphylla*, Joshi and Kambhoja (1959) on *Gisekia pharnecioides.* Joshi and his students are doing autecological studies on a number of plants like *Trianthema decandra, T. portulacastrum, T. triquetra and Mollugo nudicaulis* etc. A complete flora of Rajasthan (Puri *et al*, 1959) and Kutch (Puri *et al*, 1958) has been prepared by the Botanical Survey of India and some shorter accounts on ecology and new records of species have also been prepared (Jain, 1960).

The UNESCO and Government of India have recently set up an Arid Zone Research Institute at Jodhpur. It has devised and demonstrated effective methods of planting trees and grasses for stabilizing shifting sand and the regeneration of natural grazing lands by protection from overgrazing (Nixon, 1958). A Soil survey and Conservation station has also been set up at Kotah which is doing very useful work.

However, no attempt has been made so far to study the Arid Zones of India on detail ecological basis. Puri (1960) has given a Survey of our present knowledge. The present paper gives details of vegetation of Churu, Rajasthan.

Situation and Topography :

Churu is an important town in the Bikaner division of Rajasthan. It lies between 73°5′ to 75°5′ E. longitude and 27°5′ to 29°0′ N. latitude. There is a vast expanse of sand all around Churu town with accumulations at many places leading to the formation of dunes. These dunes are usually stable but during the summer season, when the wind velocity is high, they become mobile.

Climate :

The climate of the region is arid characterised by frequent drought. During 1959 and 1960 the mean monthly temperatures fluctuate between 4°C to 42°C. May and June are the hottest months, when the mean temperature shoots upto 41·6°C. The coldest month is January when the mean maximum and minimum temperatures are 22·5°C and 4·0°C respectively (See Table I).

The rainfall is scanty and irregular. The total annual rainfall for the year 1960 stood at 295·8 mm. (11·0 inches) only. It is mainly received during the monsoon months from July to September. Winter rains are negligible.

Wind velocity is quite high during summers and sand storms are a common feature of the area. The mean maximum wind velocity is 16·7 Km. per hour in the month of June. The meam minimum wind velocity is 4·3 Km. per hour in November.

It is thus evident that the desert plants are subjected to a severe drought during which high wind velocity is accompanied by low relative humidity. Under these conditions the evaporation rate is high and only those species are successful which have a capacity to withstand the environment.

TABLE I

Climatological Data

Month	Mean Max. Temp. °C.	Mean Min. Temp. °C.	Monthly total rainfall mm.	Mean wind velocity Km. p.h.
July, 1959	37·5	27·6	50·3	13·1
August, 1959	35·4	16·1	165·6	11·6
September, 1959	34·2	24·9	83·2	8·2
October, 1959	35·2	20·0	9·8	6·5
November, 1959	28·6	11·2	13·0	4·3
December, 1959	24·9	5·7	0·0	4·4
January, 1960	22·5	4·0	0·0	5·0
February, 1960	29·4	8·3	0·0	5·0
March, 1960	29·9	12·9	6·3	8·0
April, 1960	35·6	17·7	2·4	8·7
May, 1960	41·5	24·0	14·8	11·2
June, 1960	41·6	28·9	31·9	16·7
July, 1960	36·7	27·1	122·3	13·6
August, 1960	35·0	26·4	118·1	10·6
September, 1960	36·8	24·4	0·0	8·9

Edaphic factors :

The soil is sandy in lexdure and light yellowish brown to dark brown in colour as observed from the Munsell Soil Colour chart. It is porous and hence the water holding capacity is low. The water readily percolates down to deeper zones.

Biotic Factors :

All type of biotic factors such as felling and coppicing of trees, grazing, trampling, etc. are prevelent.

Methods of Study :

Vegetation was recorded in quadrats by the method given by Misra and Puri (1954).

Vegetation :

The vegetation of Indian desert is sparse type according to the description of World vegetation prepared by Fosberg (1961). It can be divided into two groups—the one depends mainly on rain water while another is supported by the presence of subterranean water. The plants dependent on rain water are the ephemerals which are infact annuals appearing immediately after the first showers and which develop, flower, fruit and shed seeds in a remarkably short time of two to three months. On the other hand, there is a group of plants thriving in absence of rain water. These are the perennials with long, deeply descending roots, to absorb the subterranean water. They are endowed with certain

capacities which enable them to resist drought during the severe dry summer when the rate of evaporation is maximum.

The common plants that come up after the first few showers are *Tephrosia purpurea, Mollugo nudicaulis, M. cerviana, Crotalaria burhia, Trianthema monogyna, Boerhaavia diffusa, Gisekia pharnecioides, Gynandropsis pentaphylla, Digera arvensis, Tribulus terrestris, Amaranthus viridis, Heliotropium strigosum, Calligonum polygonoides, Calotropis procera, Aerus tomentosa, Cyperus arenarius, Leptadenia spartium, Zizyphus nummularia.*

A number of grasses also come up during the rainy season. The common ones are *Cenchrus catharticus, Eleusina algyptiaca, Eragrostis ciliaris, E. pilosa, Urochloa panicoides, Digitaria marginata. Perotis* sp., *Aristida adscencionis, A. hystrix, Panicum antidotale, Dactylotenium aegyptiaca* etc.

Species which continue to thrive during winter are *Calligonum polygonoides, Calotropis procera, Aerua tomentosa, Tephrosia purpurea, Leptadenia spartium, Zizyphus nummularia, Crotalaria burhia* and a few grasses. Along with these the new plant *Argemone mexicana* dominates some spots.

The tree aspect of the desert landscape consists of *Prosopis spicigera, Zizyphus mauratiana, Acacia arabica, Gymnosporia montana, Salvadora persica, Capparis decidua.* etc. *Prosopis spicigera* is the most frequent tree of the area and the desert as a whole.

Composition of the communities :

Five major communities have been recognised in the area during the best periods of growth :

1. *Calotropis—Calligonum -- Gisekia – Urochloa* community on dry sandy plains.
2. *Urochloa—Aerua—Leptadenia - Gisekia* community on dry sandy plains.
3. *Prosopis—Dactyloctenium—Urochloa—Eragrostis* community on dry sandy plains.
4. *Calligonum—Aristada—Dactyloctenium—Perotis* community on sandy plains.
5. *Cenchrus– Leptadenia* community on sandy plains with slight moisture.
6. *Tephrosia—Cyperus—Cenchrus* community on sandy plains with moisture.

Detail phytosociological characters of these communities are given below :

1. *Calotropis—Calligonum—Gisekia—Urochloa* community.

The quantitative characters are given in Table II. This community is characterised by the dominance of *Calotropis procera, Calligonum polygonoides, Gisekia pharnecioides* and *Urochloa panicoides.* Average number of plants per unit area is, however, greatest in *Dactyloctenium aegyptiaca* and *Gisekia pharnecioides.* The other important species having 60% frequency are *Boerhaavia repanda* and *Dactyloctenium aegyptiaca.* Species of rare occurrence are *Boerhaavia diffusa, Cenchrus seligerus* and *Panicum antidotale.* The community occupies drier situations.

2. *Urochloa—Aerua—Leptadenia—Gisekia* community :

In all sixteen species have been recorded in this community which is dominated by *Urochloa panicoides, Aerua tomentosa, Leptadenia spartium* and *Gisekia pharnecioides.* All these plant species have higher abundance. The plants having 60–80% frequency are *Calligonum polygonoides, Cyperus arenarius* and *Cenchrus catharticus.* The following species are only with 20% frequency : *Boerhaavia repanda, Crotalaria burhia,*

Calotropis procera, Digitaria marginata, Eleusine aegyptiaca, Mollugo cerviana and the bush *Zizyphus nummularia.* The community occupies comparatively drier situations.

3. *Prospois—Dactyloctenium—Urochloa—Eragrostis* community :

The quantitative characters of this community are given in table IV. The community looks like a savannah with interrupted trees of *Prosopis spicigera* and open spaces with sparse vegetation. The dominant species are *Prosopis spicigera, Dactyloctenium aegyptiaca, Urochloa panicoides, Dactyloctenium aegyptiaca* and *Eragrostis ciliaris* have the maximum abundance. Quadrats plotted in this community were intentionally put under the shade of *Prosopis spicigera* tree taking the stump of the tree in the middle. This was done to note the effect of shade on the plants. A comparison could also be made with the adjoining open areas in between the two *Prosopis spicigera* trees. The vegetation under the *Prosopis spicigera* canopy will be described first.

The number of species under the shade is by far the highest amongst all the communities, being 23. The plants have comparatively the best growth and cover larger areas. *Dactyloctenium aegyptiaca* acquires mat form of habit growing luxuriantly with an average of 35 plants per quadrat. *Cenchrus catharticus, Calotropis procera, Eragrostis ciliaris* and *Urochloa panicoides* are the other species which take advantage in the shade and grow with greater abundance. *Dactyloctenium aegyptiaca* and *Urochloa panicoides* are the constant species of the shade with 100% frequency. Next in order are *Cenchrus catharticus, Eragrostis ciliaris* and *Leptadenia spartium.*

In between two *Prosopis spicigera* trees the vegetation is again sparse. The important species are *Calotropis procera, Aerua tomentosa, Leptadenia sparticum* and *Calligonum polygonoides.*

4. *Calligonum—Aristida—Dactylortenium—Perotis* community :

This community also occupies drier situations and is dominated by *Calligonum polygonoides* and *Aristida hystrix.* Total number of species is 20 with *Dactyloctenium aegyptiaca, Aristida hystrix, Eragrostis ciliaris* and *Perotis* sp. as the abundant plants. The number of plants of *Calligonum polygonoides* is, however, less. This lpecies is a shrub and may occur in varying heights from 1 foot to 5 feet. This sast named species and *Aristida hystrix* have 100% frequeney. *Zizyphus nummularia, Perotis* sp., *Dactyloctenium aegpytiaca* and *Cenchrus catharticus* are the important species having 80% frequency (see Table V).

5. *Cenchrus—Leptadenia* community :

This community occupies little depressions or otherwise where the soil moisture is little more. It appears to be dominated by only one species and that is the grass *Cenchrus catharticus.* The species has singular plants without any clump formation at the base. Obviously, the ground is quite visible. The dominant species has the largest number of plants per unit area followed by *Urochloa panicoides.* Only the dominant species has 100% frequency in the community. Species with 60–80% frequency are *Cyperus arenarius, Calligonum polygonoides* and *Leptadenia spartium.* Quantitative data are given in Table IV.

6. *Tephrosia—Cyperus—Cenchrus* community :

This community occupies a little or more moister conditions than the foregoing community. The community which is dominated by *Tephrosia purpurea* and *Cyperus arenarius* has a little thicker mantle of vegetation. As a matter of fact, *Cyperus arenarius* clumps grow in the shade of *Tephrosia purpurea* woody herb. Dominant species have the largest abundance. However, only *Tephrosia purpurea* has

100% frequency. *Cyperus arenarius* and *Cenchrus catharticus* show 80% of freqnency in the area. Remaining species have low frequencies (see Table VII).

DISCUSSION

The five communities of desert habitat are intermingled with each other through a number of species. This is natural as the area is open to severe human interference and the dispersal of plants in open habitats is strongly facilitated by animals, man and wind. However, vegetation is sparse even during the best periods of growth, *i.e.*, September—October. Only one tree *Prosopis spicigera* is common in the area. The vegetation under the canopy of these trees is a bit better developed. In other comparatively wetter areas during monsoon months also have better growth. Phytosociology further reveals that the total number of species as well as the average abundance of the species is low in all the communities. It is only highest under the shade. Most of the species are annuals and complete their life cycle within two to three months of monsoon. Succeeding period is dry and excepting for a few bushes of species like *Calligonum polygonoides, Calotropis procera, Zizyphus nummularia, Leptadenia spartium, Aerua tomentosa* and scattered trees of *Prosopis spicigera*, the area gives a barren appearance. Of these enduring species *Calligonum polygonoides* and *Leptadenia spartium* bear leaves only during rainy season.

TABLE II

Calotropis—Calligonum—Gisekia—Urochloa community

No.	Name of the plants	No. of Plants in the quadrats 1	2	3	4	5	Average Abundance per Quadrat	Frequency %
1.	*Aristida hystrix* Linn.	..	..	..	..	3	0·6	20
2.	*Boerhaavia repanda* Roxb.	..	2	1	..	2	1·0	60
3.	*B. diffusa* Linn.	1	..	..	2	..	0·6	40
4.	*Cyperus arenarius* Linn.	..	..	3	4	..	1·4	40
5.	*Calligonum polygoniodes* Linn.	2	2	1	1	1	1·4	100
6.	*Cenchrus setigerus* Stend.	..	..	1	..	..	0·2	20
7.	*Crotalaria burhia* Buch-Ham.	1	1	..	..	..	0·4	40
8.	*Cenchrus catharticus* Linn.	5	..	..	..	..	1·0	20
9.	*Calotropis procera* R. Br.	2	2	2	1	2	1·8	100
10.	*Dactylectenium aegypciata* Willd.	7	..	2	..	6	3·0	60
11.	*Eragrostis ciliaris* Link.	6	..	..	..	4	2·0	40
12.	*Cleusine aegyptiaca* Desf.	..	..	..	..	6	1·2	20
13.	*Gisekia pharnecioides* Linn.	7	2	..	5	1	3·0	80
14.	*Leptadenia spartium* Wight.	4	1	..	..	..	1·0	40
15.	*Mollugo cerviana* Ser.	..	2	..	..	5	1·4	40
16.	*Panicum antidotale* Retz.	..	..	..	..	2	0·4	20
17.	*Urochloa panicoides* Beauv.	8	1	2	2	..	2·6	80

TABLE III

Urochloa—Aerua—Leptadenia—Gisekia cammunity

No.	Names of plants	No. of Plants in the quadrats 1	2	3	4	5	Average Abundance per quardrat	Frequency %
1.	*Aerua tomentosa* Forsk.	3	3	4	4	2	3·2	100
2.	*Boerhaavia repanda* Roxb.	..	..	3	..	..	0·6	20
3.	*Cenchrus catharticus* Linn.	2	2	4	..	..	1·6	60
4.	*Cyperus arenarius* Linn.	2	2	3	..	..	1·4	60
5.	*Calligonum polygonoides* Linn.	1	2	..	4	1	1·6	80
6.	*Crotalaria burhia* Buch-Ham.	1	..	..	..	..	0·2	20
7.	*Calotropis procera* R. Br.	2	..	..	..	..	0·4	20
8.	*Digitaria marginata* Linn.	..	..	..	..	7	1·4	20
9.	*Eleusine aegyptiaca* Desf.	2	..	..	..	..	0·4	20
10.	*Gisekia pharnecioides* Linn.	3	4	4	2	3	3·2	100
11.	*Indigofera linifolia* Retz.	3	1	..	..	..	0·8	40
12.	*Leptadenia spartium* Wight.	2	1	2	3	4	2·4	100
13.	*Mollugo cerviana* Ser.	..	..	4	..	..	0·8	20
14.	*Perotis* Sp. Ait.	1	2	..	..	..	0·6	40
15.	*Urochloa panicoides* Beauv.	15	12	10	25	10	12·4	100
16.	*Zizyphus nummularia* Burm. f.	..	..	..	1	..	0·2	20

TABEE IV

Prosopis—Dactyloctenium—Uroehloa—Eragrostis community

No.	Name of plants	No. of plants in the quadrats 1	2	3	4	5	Average Abundance per quadrat	Frequency %
1.	*Aristida hystrix* Linn.	9	..	..	..	..	1·8	20
2.	*Boerhaavia diffusa* Linn.	2	..	..	2	3	1·4	60
3.	*Borreria hispida* DC.	1	..	..	2	1	0·8	60
4.	*Calligonum polygonoides* Linn.	..	..	..	2	3	1·0	40
5.	*Cenchrus catharticus* Linn.	..	4	1	2	4	2·2	80
6.	*Corchorus acutangulus* Lam.	1	..	..	1	..	0·4	40
7.	*Calotropis procera* R. Br.	1	2	..	3	3	1·8	80

No.	Name of plants	No. of plants in the quadrats 1	2	3	4	5	Average Abundance per quadrat	Frequency %
8.	*Crotalaria burhia* Buch-Hann.	..	..	..	..	3	0·6	20
9.	*Dactyloctenium aegyptiaca* Willd.	25	31	42	39	38	35·0	100
10.	*Digitaria marginata* Link.	..	..	2	..	7	1·8	40
11.	*Fragrostis ciliaris* Link.	18	21	..	11	5	11·0	80
12.	*F. phemosa* Link.	6	..	..	..	..	1·2	20
13.	*Farsettia Jacquemontii* Hk. f. and T.	..	..	..	2	1	0·6	40
14.	*Leptadenia spartium* Wight.	..	..	2	4	5	2·2	60
15.	*Mollugo nudicaulis* Lamk.	2	..	..	..	1	0·6	40
16.	*Phyllanthus simplex* Retz.	..	..	..	1	..	0·2	20
17.	*Prosopis spicigera* Linn.	1	1	1	1	1	1·01	100
18.	*Physalis minima* Linn.	..	..	..	..	1	0·2	20
19.	*Salvadora persica* Linn. seedling	..	..	..	1	2	0·6	40
20.	*Perotis* sp. Ait.	..	..	..	5	7	2·4	40
21.	*Tribulus terrestis* Linn.	..	..	1	..	1	0·2	40
22.	*Urochloa panicoides* Beauv.	2	7	6	3	4	4·4	100
23.	*Zizyphus nummularia* Burm. f.	2	...	..	..	3	1·0	40

TABLE V

Calligonum—Aristida—Dactylactenium—Perotis community

No.	Name of plants	No. of plants in the quandrats 1	2	3	4	5	Average Abundance per quadrate	Frequency %
1.	*Aristida hystrix* Linn.	2	5	4	3	6	4·0	100
2.	*Boerhaavia repanda* Roxb.	1	..	..	1	1	0·6	60
3.	*Cenchrus catharticus* Linn.	1	..	2	2	4	1·8	80
4.	*Crotalaria burhia* Buch-Hann.	..	..	1	..	1	0·4	40
5.	*Cyperus arenarius* Linn.	..	..	1	..	..	0·2	20
6.	*Calligonum polygonoides* Linn.	2	1	1	2	1	1·4	100
7.	*Dactyloctenium aegyptiaca* Willd.	25	18	12	11	..	13·2	80
8.	*Digitaria marginata* Link.	..	..	..	3	..	0·6	20
9.	*Euphorbia thymifolia* Forsk.	1	..	..	1	..	0·4	40

No.	Name of plants	No. of plants in the quadrate					Average Abundance per quadrat	Frequency %
		1	2	3	4	5		
10.	*Eragrostis ciliaris* Link.	10	9	..	5	..	4·8	60
11.	*E. phimosa* Link.	..	..	..	2	..	0·4	20
12.	*Farseptia jacquemontii* Hk. f. and T.	3	..	..	..	..	0·6	20
13.	*Leptadenia spartium* Wight.	..	2	..	..	..	0·4	20
14.	*Mollugo nudicaulis* Lamk.	..	2	2	2	..	1·2	60
15.	*Polygala simplex* Burch.	1	..	1	..	..	0·2	40
16.	*Perotis* sp. Ait.	..	5	5	4	5	3·8	80
17.	*Tragus biflorus* Schutt.	1	..	..	..	..	0·2	20
18	*Trianthema monogyna* Linn.	..	5	..	..	2	1·4	60
19.	*Urochloa panicoides* Beauv.	2	..	2	1	..	1·0	60
20.	*Zizyphus nummularia* Burm. f.	1	4	2	2	..	1·8	80

TABLE VI

Cenchrus—Leptadenia community

No.	Name of plants	No. of plants in the quadrats					Average Abundance per quadrat	Frequency %
		1	2	3	4	5		
1.	*Aristida adscencionis* Linn.	..	2	..	..	..	0·4	20
2.	*Boerhaavia diffusa* Linn.	2	..	..	..	..	0·4	20
3.	*B. repanda* Roxb.	..	..	..	4	..	0·8	20
4.	*Brachiaria ramosa* Griseb.	..	..	..	2	..	0 4	20
5.	*Cenchrus catharticus* Linn.	16	14	11	13	15	13·8	100
6.	*Cyperus arenarius* Linn.	..	1	1	3	..	1·0	60
7.	*Calligonum polygonoides* Linn.	2	..	5	2	..	1·8	60
8.	*Calotropis procera* R. Br.	..	..	2	..	..	0·4	20
9.	*Fragrostis plumosa* Link.	..	4	..	..	..	0·8	20
10.	*E. ciliaris* Link.	..	..	..	..	3	0·6	20
11.	*Euphorbia thymifolia* Forsk.	..	..	..	..	1	0·2	20
12.	*Gisekia pharnecioides* Linn.	2	1	..	..	..	0·6	40
13.	*Leptadenia spartium* Wight.	2	2	2	..	2	1·6	80
14.	*Mollugo cerviana* Ser.	..	1	..	..	..	0·2	20
15.	*M. nudicaulis* Lamk.	1	..	..	..	..	0·2	20
16.	*Polygala simplex* Burch.	..	..	..	..	1	0·2	20
17.	*Tribulus terrestris* Linn.	..	..	..	6	..	1·2	20
18.	*Urochloa panicoides* Beauv.	..	.	12	7	..	3·8	40

TALLE VII

Tephrosia—Cyperus—Cenchrus community

No.	Name of plants	No. of plants in the quadrats					Average Abundance per quadrat	Frequency %
		1	2	3	4	5		
1.	*Aerua tomentosa* Forsk.	..	..	..	..	1	0·2	20
2.	*Cyperus arenarius* Linn.	11	10	8	..	1	6·0	80
3.	*Cenchrus catharticus* Linn.	4	5	4	..	1	2·8	80
4.	*Crotalaria burhia* Buch-Hann.	4	1	..	..	..	1·0	40
5.	*Calligonum polygonoides* Linn.	..	..	..	1	1	0·4	40
6.	*Eleusine aegyptiaca* Desf.	..	..	4	1	..	1·0	40
7.	*Erogrostis ciliaris* Link.	..	..	..	4	..	0·8	20
8.	*E. Pilosa* Beauv.	..	..	..	..	1	0·2	20
9.	*Euphorbia thymifolia* Forsk.	..	..	..	2	..	0·4	20
10.	*Gisekia pharnecioides* Linn.	..	..	..	2	..	0·4	20
11.	*Indigofera linifolia* Retz.	..	..	..	..	1	0·2	20
12.	*Leptadenia spartium* Wight.	..	..	4	..	1	1 0	40
13.	*Mollugo cerviana* Ser.	..	1	..	..	..	0·2	20
14.	*Tephrosia purpurea* Pers.	6	2	5	2	4	3·8	100
15.	*Urochloa panicoides* Beauv.	..	..	7	..	2	1·8	40

It must be clearly mentioned here that the above described six communities are not all and the remaining communities are being studied.

SUMMARY

1. Phytosociological study of the vegetation around Churu town in Rajasthan has been described.
2. A short review of the available literature on Arid Zone studies is given.
3. Environmental factors affecting the growth of vegetation are mentioned.
4. Six plant communities which are very frequent in the area haye been described.

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DAMPING OFF OF CHILLI (*CAPSICUM ANNUUM* L.)

By

S. C. ATHEYA *and* BABU SINGH

Dept. of Botany, Govt. Agricultural College, Kanpur

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Damping-off of chilli seedlings was seen in a severe form in seed beds during rainy and winter season of 1949–50, in the Botanical Garden, Government Agricultural College, Kanpur. A survey of the disease in Mathura, Agra, Aligarh, Lucknow, Kanpur showed it to be prevalent in those localities. The disease is caused by species of *Pythium*, *Rhizoctonia* and *Fusarium*. Matz (1921) reported *R. pallida* causing root-rot of chilli seedlings in Porto Rico. According to Higgins (1923) species of *Rhizoctonia* and *Pythium* are responsible for damping off in Georgia. Ramos (1926) from Philippines and McRae (1928) from India reported *P. aphanidermatum* causing considerable damage to chilli seedlings in Pusa, Bihar. Narasimhan from Mysore (1934) and Person & Chilton (1942) from Hungary attributed *P. debaryanum* as the causal agent of damping off of chilli seedlings. No comprehensive work has been done on this disease so far. The present investigation was undertaken to study the morphology and pathogenicity of the causal organism and measures to effectively control the disease.

SYMPTOMS

Seedlings of six to ten days are most susceptible to the attack of damping off disease. The pathogen attacks the hypocotyl at the ground level causing rot of the invaded part. The affected seedlings topple over and die due to the rotting of the collar (Plate 1). In cases of severe infection the entire seedlings may be affected. Twelve to sixty-eight per cent of the chilli seedlings are damaged by this disease.

MATERIALS AND METHODS

Isolations were done by plating the diseased portions of damped off seedlings collected from various nurseries on Potato-dextrose agar plates. The dried portions were dipped in alcohol before plating. Species of *Pythium*, *Rhizoctonia* and *Fusarium* were repeatedly isolated.

The morphology of the fungi was studied on 2% Potato-dextrose agar, chilli-seedlings agar, Agar medium 'A' and Agar medium 'B'.